Teachers' Confidence with Technology:

Perceptions of the Impact of a Student Laptop Computer Program in Trinidad and Tobago.

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DEDICATION

To my six loving grandchildren who are the future of the technological world:

Salahuddeen, Khaalid, Saskia, Ellery, Liam, and Logan.

DECLARATION OF ORIGINALITY

This thesis contains no material which has been accepted for a degree or diploma by the University of Tasmania or any other institution, except by way of background information and duly acknowledged in the thesis, and to the best of my knowledge and belief no material previously published or written by another person except where due acknowledgement is made in the text of the thesis, nor does the thesis contain any material that infringes copyright.

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STATEMENT OF ETHICAL CONDUCT

The research associated with this thesis abides by the international and Australian codes on human experimentation, and the ruling of the Committees of the University of Tasmania.

Signature:

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ASSOCIATED PUBLICATIONS

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ABSTRACT

The government of Trinidad and Tobago provided free personalised laptop computers for all students transitioning from primary schools to secondary schools since 2010. This was made possible through the eConnect and learn program. The impact of this program on teachers' use of computer based technology in the classroom was the focus of this study. The investigation was undertaken using four constructs of the Technological Pedagogical Content Knowledge framework: Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Technological Pedagogical Content Knowledge (TPACK).

A mixed methods approach was adopted to probe eight research questions in two phases. The first phase was the completion of the TK and TPACK surveys by teachers (n = 173) from 12 secondary schools and pre-service teachers (n = 53) from two campuses of the University of Trinidad and Tobago. The second phase consisted of a series of one-on-one, semi-structured interviews for in-service teachers (n = 21), pre-service teachers (n = 15), ICT technicians (n = 5), school supervisors (n = 3), and the Director of the eConnect and Learn program (n = 1).

Statistical analyses with SPSS revealed there was a significant difference between in-service and pre-service teachers' confidence to integrate ICT for teaching and student learning. Final year pre-service teachers studying for an undergraduate degree were more confident in the integration of ICT than the in-service teachers. Teaching experience and qualification also impacted on teachers' TK, TPK/TCK, and TPACK scores. Teachers with less than 10 years of teaching experience as well as pre-service teachers had higher mean TK, TPK/TCK, and TPACK scores than teachers who were employed in secondary schools for more than 10 years. As part of the research, a comparison was made of the TPACK scores between pre-service teachers from an

Australian University and the University of Trinidad and Tobago. Australian pre-service teachers had higher mean scores in five out of 20 TPACK items. In contrast, the Trinidad and Tobago pre-service teachers had a higher mean score in one item. Overall, both cohorts demonstrated a high level of consistency in their confidence to use ICT and support students' use of ICT in 14 items of the survey.

The qualitative interview data were analysed using a modified form of coding strategies from grounded theory and thematic approach supported by NVIVO. Four common themes were identified: teacher support; challenges of the eConnect and Learn program; pedagogy with computers and related devices; and implications for the future of the program. Teachers perceived factors such as insufficient professional development, inadequate resources, inappropriate infrastructure, and lack of time for collaboration reduced the full implementation of the eConnect and Learn program. The eight stages of the Levels of Teaching Innovation model developed by Moersch (2010) were used to review and interpret Trinidad and Tobago teachers' pedagogical practices with computers and related devices. The majority of the teachers' responses occurred at the Awareness Level (Level 1) where teachers utilised mainly PowerPoint and videos. Few responses occurred at the higher levels.

The study concludes with the conceptualisation of a Learning Environment Model aligned with the Levels of Teaching Innovation and the seven constructs of Technological Pedagogical Content Knowledge. It is contended this framework provides a greater understanding on how to facilitate teachers' ability to integrate and evaluate technology integration for 21st Century teaching and learning in the classroom. Thus, this framework has the potential to contribute to a better understanding of how teachers can assist students to become more technologically proficient especially with eLearning which is important for the current and future knowledge economy.

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GLOSSARY OF TERMS AND ACRONYMS

1: 1 Computing	One mobile device per child such as a laptop computer, tablet, or netbook. This is sometimes referred to as a one to one program and is sometimes written as 1:1 or 1-1
21st Century skills	Skills such as critical thinking, problem solving, decision making, metacognitive skills, collaboration, team work, and constructing knowledge (ACOT2, 2008)
ACARA	Australian Curriculum Assessment and Reporting Authority
ACOT	Apple Classrooms of Tomorrow-Today. Sometimes it is written as ACOT2 or $ACOT^2$
BECTA	British Educational Communications and Technology Agency
CK	Content Knowledge
CSEC	Caribbean Secondary Examination Certificate
Denominational schools	Schools managed by a specific religious board
eLearning	Learning using electronic technology
GORTT	Government of the Republic of Trinidad and Tobago
Government schools	Schools managed by the government of Trinidad and Tobago
ICT	Information and Communications Technology
ICT4E	Information and Communications Technology for Education
In-service teachers	Teachers employed in schools
ISTE	International Society for Technology in Education
LEM	Learning Environment Model
LEM-LT	Learning Environment Model and the alignment of the Levels of Teaching Innovation with Technological Pedagogical Content Knowledge
LoTi	Levels of Teaching Innovation
MKO	More knowledgeable other

MOE	Ministry of Education in Trinidad and Tobago
NAPLAN	National Assessment Program Literacy and Numeracy
NCCA-ICT	National Council for Curriculum and Assessment - Information and Communication Technologies
OLPC	One Laptop per Child
PK	Pedagogical Knowledge
PCK	Pedagogical Content Knowledge
Pre-service teachers	Candidates studying to become qualified teachers
SAMR	Substitution, Augmentation, Modification, Redefinition Model
School type	Denominational or government school
Star.tt	An ICT program in rural areas of Trinidad and Tobago
TCK	Technological Content Knowledge
TEL	Technology Enhanced Learning
TPK	Technological Pedagogical Knowledge
Teaching practicum	A period of practical teaching experience conducted under the supervision and support of a more experience teacher in a school environment
TK	Technological Knowledge
TPACK	Technological Pedagogical Content Knowledge
UNICEF	United Nations International Childrens Emergency Fund

CHAPTER 1: INTRODUCTION

1.1 Research Overview

This study investigated teachers' confidence to utilise technology in the learning environment as well as teachers' perceptions of the impact of a student laptop computer program in Trinidad and Tobago. The program, eConnect and Learn, was introduced in my home country, Trinidad and Tobago, in 2010. It provided personalised HP 4000 laptop computers for each student transitioning from primary school (11 years to 12 years of age) to secondary school (Gopeesingh, 2010a). I was overwhelmed by the potential of this innovation to catalyse new approaches for 21st Century teaching and learning. Having a total of 31 years of teaching experience in Trinidad and Tobago, the USA, Kuwait, and Australia, I was certain my pedagogical experiences would contribute to a robust study. October 2013 was an opportune time to investigate the effectiveness of the eConnect and Learn program.

It needs to be stated upfront and as background for this research that providing a computer to each high school student is a positive initiative, particularly in a country like Trinidad and Tobago which has significant pockets of both rural and urban poverty (United Nations Development Program, 2012). Such poverty would prevent many families and schools from affording a school and home computer to assist Trinidad and Tobago students' education. It also needs to be acknowledged that education is still a powerful tool to reduce future poverty and to advance the prospects of all individuals to achieve their potential and a meaningful life (UNICEF, 2015). Although the UNICEF *Convention on the Rights of the Child* does not yet specifically mention technology education to be part of the knowledge world economy, technology education is becoming increasingly more important to assist individuals achieve their potential (ACOT2, 2008). In particular, providing students with open access to technology via a laptop computer has the potential to facilitate 21st Century learning for all students (ACOT2, 2008).

Rather than investigate Trinidad and Tobago's eConnect and Learn program from the students' or their families' perspective, I was interested in investigating the pre-service (student-teachers enrolled in courses for the Bachelor of Education degree) and in-service teachers' (teachers employed in secondary schools) perceptions of the program. I was also interested in placing this investigation in a broader context which related to the Trinidad and Tobago teachers' confidence and knowledge to use technology and eLearning strategies in the classroom. In part, this involved investigating the corpus of knowledge that both pre-service and in-service teachers needed to integrate Information and Communications Technology (ICT) more effectively into their teaching and assist students' eLearning. To take the research further, I wanted to compare Trinidad and Tobago and Australian pre-service teachers' use of ICT to support their students' use of ICT.

This chapter presents the framework for the current research and introduces the background of Trinidad and Tobago in order to provide better understanding and insight from different perspectives of the study. A brief outline of the bilateral relationship between Trinidad and Tobago and Australia follows. The chapter continues with ICT initiatives from 1999 to 2014 in Trinidad and Tobago. Statement of the problem and the purpose of the study are outlined. Theoretical underpinnings of the diffusion of innovations, followed by the aims and significance of study are discussed. Finally, a summary of the remaining chapters is presented.

1.2 Background of Trinidad and Tobago

The country of Trinidad and Tobago is located in the southern most archipelago of the Caribbean. Trinidad occupies 4,828 square kilometres whereas Tobago covers an area of 300 square kilometres. Historically and politically, the country has undergone many changes from 1498 when Christopher Columbus landed on the islands to the time independence was achieved in 1962. The country changed hands from the Spanish, French, Dutch, and eventually to the British. To underpin the economy, when the original inhabitants of the country became extinct, Africans were brought to work on the sugar cane, cocoa, coffee, and cotton plantations. With the emancipation of slavery in 1834 (Brereton, 2007), Indians, and a small number of Chinese, Syrians, and residents from the Middle East were brought to provide cheap labour for agriculture in 1845 (Reddock, 1986). With the discovery of petroleum in 1857, and natural gas in 1990 (Trinidad and Tobago Extractive Industries Transparent Initiative, 2012), a small number of employees were expatriated from the USA, Canada, England, Europe, and Asia to hold positions in the hydrocarbon industries. In 1962, Trinidad and Tobago evolved from a British colony to an independent nation, and in 1976 became a Republic. The official language is English but there is an extant rich dialect originated from the multi-ethnic groups settled in the country. In 2014, the population was approximately 1,332,788 (countrymeters.info/en/Trinidad_and_Tobago). In the same year the Gross Domestic Product (GDP) in Trinidad and Tobago was an all time high of $US 28.90 billion which contrasted with a record low of $US 0.54 in 1960. In 2013, the GDP per capita was $US 14275. 37. The GDP value in the country presently represents 0.05% of the world economy. (http://www.tradingeconomics.com/trinidad-and-tobago/gdp). The location of Trinidad and Tobago is illustrated in Figure 1.

Figure 1. Location of Trinidad and Tobago
Retrieved from
http://www.worldatlas.com/webimage/countrys/namerica/caribb/ttcarib.gif

1.3 Education System of Trinidad and Tobago

The education system in Trinidad and Tobago has evolved from the British system but many changes were made. Its four-tiered system commences with pre-school (3 to 5 years of age), followed by primary (5 to 12 years of age), secondary (12 to 17/19 years of age), and finally tertiary levels (> 17 years). Each tier is not structurally and physically connected to each other. Formal education is free from early childhood to an undergraduate degree. All children are mandated to attend primary and secondary schools. Breakfast, lunch, books and transportation are provided at no cost

(Ministry of Education, 2004) to the parents. There are 548 primary schools and 199 secondary schools.

As a result of the cosmopolitan landscape of the country, school type consists of denominational, government, private and international schools. Schools are either coeducation with both male and female students or single gender with either male students or only female students. Whereas denominational schools are under the management of a religious board (Hindu, Muslim, or other sectors of Christianity), government schools are totally managed by the Ministry of Education (MOE) (Steinbach, 2012). Both school types are financed by the Ministry of Finance, however, the Ministry of Education has the overall responsibility for the supervision of these institutions (Ministry of Education [MOE], 2008). Privately owned schools and international schools are independently financed and controlled by their managerial boards. Whereas the government, denominational, and privately owned schools deliver the national curriculum, the international schools offer the curriculum from their home countries such as Canada, America, and England. To date, there is an urgent need for the Ministry of Education to develop an efficient relief system to replace teachers' absenteeism on a daily basis in primary and secondary schools.

Tertiary education in Trinidad and Tobago falls under the jurisdiction of the Ministry of Science, Technology and Tertiary Education except for teacher education which is under the portfolio of the Ministry of Education (MOE, 2008). Accessibility to tertiary education is obtained from two universities, the University of the West Indies and the University of Trinidad and Tobago. Tertiary education is also supplemented by a total of nine local and international private institutions. Together, all of the institutions respond to the needs of the country in terms of its industries, education, entrepreneurship, innovation, and global trends in technology developments (https://u.tt/index.php?accreditation=1&page_key=704). Table 1 presents the location and the total number of government, denominational, and private secondary schools in the eight educational districts of Trinidad and Tobago. Comparable data were not made available for the international institutions in Trinidad and Tobago.

Table 1

School Types and Location of Secondary Schools in Trinidad and Tobago

District	Location	Government	Denominational	Private
Caroni	Semi-urban	13	7	5
North Eastern	Semi-rural	12	3	4
Port of Spain	Urban	15	9	3
South Eastern	Rural	13	3	2
St George East	Semi-urban	12	5	12
St Patrick	Rural	9	5	0
Tobago	Semi-rural	6	3	1
Victoria	Semi-urban	11	8	2
Total		91	43	29

Note. Adapted from the Ministry of Education [MOE] (2011).

An inspection of Table 1 indicated government secondary schools outnumbered the denominational and private institutions in each of the educational districts.

1.3.1 Trend for gender.

Comparison of the trend for gender of teachers in secondary schools in Trinidad and Tobago was investigated. There were more females than males in the teaching service (Ministry of Education, personal communication, December 10, 2014). A comparison of teacher population in terms of female to male for the year 1994 to 1995 was 56% to 44%. A feminising trend continued in 2002 to 2003 with an increase in the number of female teachers to 61% and a decline in the male population to 39% in the secondary schools. The greatest increase in employment of female teachers was recorded in 2010 when candidates who were pursuing an undergraduate degree no longer had to pay tuition fees (The Observatory on Borderless Higher Education, 2005). By 2013-2014 there was a further decrease in the number of male teachers to 31%. The sample of teachers in the study was therefore broadly representative of this increasingly feminized workforce. Similar findings were present internationally. For example, the total number of male teachers had dropped from 55% in 1981 to 42% in Australia in 2011 (Weldon, 2015). Figure 2 illustrates the trend for gender of teacher population in secondary schools in Trinidad and Tobago from 1994 to 2014.

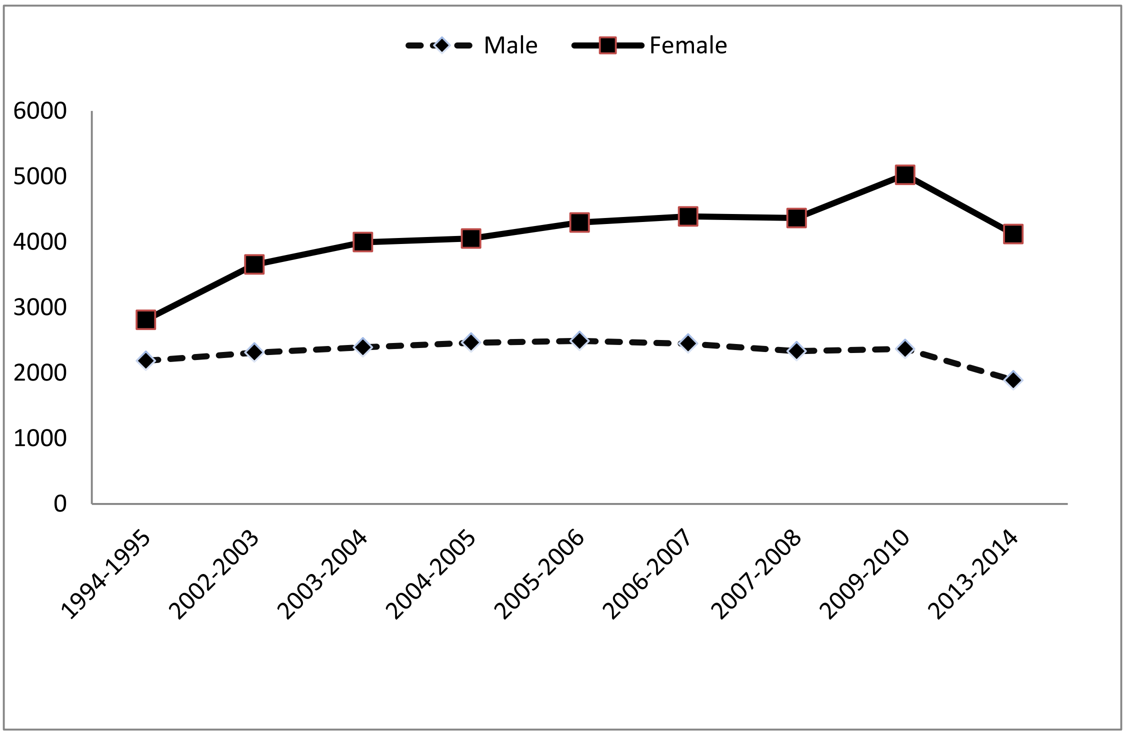


Figure 2. Teacher population for 1994 to 2014 in Trinidad and Tobago (Quamina-Aiyejina et al., 2001; Ministry of Education, 2013)

1.4 Relationship Between Trinidad and Tobago and Australia

According to the country's brief (http://dfat.gov.au/geo/trinidad-tobago/Pages/trinidad-and-tobago-country-brief.aspx), Trinidad and Tobago has a close bilateral relationship with Australia in terms of sports, joint members of the Commonwealth, the United Nations, and commercial links. The Australian High Commission was established in Port of Spain, Trinidad, in July 2004. Trinidad and Tobago is one the largest trading partners with Australia in the Caribbean. Meat and cheese are imported while alcoholic beverages and essential oils and perfumes are exported. Two Australian passenger ferries (Incat) at a cost of $US 15, 000,000 ($TT 90,000,000) were purchased from Australia in 2006. In addition, six patrol boats from Austal were purchased in 2009. In terms of the energy sector, BHP Billiton is a major oil producer, and co-operates the Angostura gas project with partners FinELf. Activities such as the Commonwealth Heads of Government Meeting in 2009 and 2011 exchanged visits by Prime Ministers from each country (http://dfat.gov.au/geo/trinidad-tobago/Pages/trinidad-and-tobago-country-brief.aspx). Trinidad and Tobago received four scholarships and two fellowships from Australia during the period 2010-2011.

1.4.1 Comparison of Trinidad and Tobago and Australian education systems.

The employment of teachers in Trinidad and Tobago and Australia is structured differently. In Trinidad and Tobago, employment of teachers in all government and denominational schools is the responsibility of the Ministry of Education (Government of the Republic of Trinidad and Tobago, 2012). In Australia, the Department of Education employs teachers in the government schools, whereas the Principals of Catholic and Independent schools (private schools) are responsible for employment of members of their staff (Department of Education and Training, 2015). Unlike America, Canada, England, and Australia, teachers in Trinidad and Tobago are employed in the teaching service with or without teaching certification.

In terms of Assessment, students from Years 3, 5, 7 and 9 (between the ages of 7/8 years and 15/16 years) participate in Australia's National Assessment Program in Literacy and Numeracy (NAPLAN) (Australian Curriculum and Assessment Reporting Authority [ACARA], 2009). The results obtained are indicators of students' performance and are used by school administrators to determine skills that need improvement. In contrast, students at the primary level from Standard 3 (9 years of age) and Standard 4 (10 years of age) in Trinidad and Tobago participate in the national Continuous Assessment Component program (Government of the Republic of Trinidad and Tobago [GORTT], 2012). Curriculum areas assessed are science, mathematics, physical education, visual and performing arts, drama, dance, technical and vocational skills, as well as civic education. A total of 20% of the scores in Standard 3 and 40% in Standard 4 are added to the Secondary Entrance Examination, which takes place in Standard 5 (>11 years of age). This examination is compulsory before transitioning to secondary schools. Australian students normally transition from primary to secondary schools without standardised testing.

Another difference between both countries reflects certification for graduation from secondary schools. Australian students receive a Certificate of Education which consists of the cumulative scores of each subject completed after four years at secondary school. On the other hand, students in Trinidad and Tobago need to be successful in the Caribbean Secondary Examination Certificate (CSEC) at the end of five years of schooling before graduation. Both cohorts of students have the option to participate further in a two year-program at the secondary level.

1.5 Information and Communications Technology Initiatives in Trinidad and Tobago

Between the years 1998 and 2001, the Ministry of Education in Trinidad and Tobago provided subsidies for teachers to buy personalized computers. During that same period, 3,000 teachers were educated with basic computer skills. Teachers were also offered to participate in a four-year part-time Information and Communications Technology (ICT) professional development course. The incentive included free tuition with the GATE (Government Assisted Tuition Expenses) program and an increase in salary. Through the National Development Strategic Plan (GORTT, 2002), schools were rebuilt and transformed to provide education for all students between the ages of three to 17 years. A national ICT Plan from 2003 to 2008 was implemented. The plan aimed to support ICT initiatives in all levels of formal education by 2008 through the Fastforward project (MOE, 2008) which enabled ICT infrastructural upgrades. High-speed internet services, dialup, broadband, and wireless hosting for businesses, residences, and schools were promoted.

By 2008, each secondary school was equipped with at least one computer lab consisting of 35 computers with internet connection (MOE, 2008). Computers on carts were also made available where necessary. A total of 532 secondary school teachers were educated in basic network administration. In addition, the National Library and Information System Authority (GORTT, 2009) provided free access to computers, internet, WiFi, and in some cases printing to all citizens including the visually challenged and physically handicapped. These measure were instituted to advance the ICT capabilities of the people of Trinidad and Tobago.

It was with this backdrop, the government provided free personalized HP 4400 or Lenovo E425 laptop computers to all students transitioning from primary schools to secondary schools (Gopeesingh, 2010b) in 2010. The Minister of Education described the laptop computers as having improved wireless capability with Bluetooth connectivity and larger internal storage to increase performance, connectivity and energy efficiency. Additionally, the computers were equipped with a faster hard drive speed, extended battery life, and material to facilitate learning, such as, Microsoft Office Home as well as Learning Essentials 2.0 for Microsoft Office.

Finally in 2014, the Star.tt program was introduced in communities of rural areas to enhance access to ICT (Mohammed, 2014). These included cyber cafe, state-of-the-art training and conference facilities, WiFi launch for mobile users, and e-government services. Figure 3 and Figure 4 illustrate rural and urban areas respectively in Trinidad and Tobago.

Figure 3. A rural area in Trinidad and Tobago.
Retrieved from http://www.ipsnews.net/2013/10/caribbean-looks-to-the-sky-for-water-security/

Figure 4. Urban area in Trinidad and Tobago.
Retrieved from http://www.gotrinidadandtobago.com/travel-information/country-information/

1.6 The eConnect and Learn program in Trinidad and Tobago

The eConnect and Learn program was introduced in Trinidad and Tobago since 2010. The primary educational objective of the program (Gopeesingh, 2010a) aimed to leverage the potential of Information and Communications Technology (ICT) in order to significantly enhance the Trinidad and Tobago education system. The secondary objective highlighted the national capacity should be strengthened to effectively utilize ICT so that Trinidad and Tobago competitiveness can be improved in the international community. In addition, it was expected citizens' access to ICT would be increased by reducing the then emerging digital divide.

Apart from a political promise to the nation by the Prime Minister (Persad-Bissesar, 2010) there were two underlying measures for the initiation of the eConnect and Learn program in the country. The first underpinned the goals of the Jomtien

Declaration (UNESCO, 1990) which mandated *Education for All* children by 2015. The second measure anticipated the program could contribute to the education of the citizens of the country and therefore would ultimately assist with the attainment of developed country status by 2020. This measure aimed at strengthening the Millennium goals which were aligned with the country's Vision 2020 plan and tailored for a fully developed nation with a strong economy and high levels of human development (United Nations Development Program, 2012).

1.7 Background and Problem Statement

Three factors contributed to the background of the problem in this study. The first was an absence of a pilot project before the distribution of the laptop computers to all students transitioning to secondary schools. The importance of pilot projects were demonstrated by seven studies relating to the One-to-One computing program in neighbouring Latin American countries (Derndorfer, 2010; Naslund-Hadley, Kipp, Cruz, Ibarraran, & Khamsi, 2009; MercoPress, 2007; Severin & Capota, 2011). Lessons learned from the pilot projects enabled informed decisions to be made for future implementation and design decisions. Unfortunately, the eConnect and Learn program was introduced in secondary schools in Trinidad and Tobago without a pilot project. Therefore, there was no evidence-based research conducted to guide the implementation process. Techno-centric approaches as opposed to socio-centric//socio-technical approaches were used. Teachers' technological pedagogical content practices in the diffusion of laptop computers in secondary schools were absent. This was unlike America, Canada, Australia and the Latin American countries where large scale preliminary studies were conducted before full implementation of such programs (Alberta Education, 2010; Severin & Capota, 2011).

The second factor which contributed to the background of the problem was the inconsistency of distribution of laptop computers for teachers. During the first year of the eConnect and Learn program in 2010, laptop computers were distributed to 17,300 students and 3,000 teachers at approximately $US 13,400,000. Subsequently, laptop computers were distributed only to students but not to the teachers. This distribution contradicted the ICT Professional Development Plan (MOE, 2012) which posited all teachers in secondary schools would receive laptop computers. The British Educational Communications and Technology Agency [BECTA], (2004) suggested the absence of laptop computers by some teachers prevented access to relevant pedagogical content information and positive engagement with ICT integration for teaching and learning.

The third factor which contributed to the background of the problem was reflected by the level of professional development delivered for ICT integration. A total of 2000 teachers employed in secondary schools in Trinidad and Tobago were educated as mentors in technical, functional and exploratory skills of computers in 2010. It was aimed to promote ICT integration in the classrooms (Gopeesingh, 2010a) but this delivery of professional ICT education focused mainly on the functionalities of computers. Successful ICT integration for teaching and eLearning requires knowledge, skills, and competencies to impart depth, richness, proficiency, confidence, and success in teaching and learning. According to a study in Canada (Alberta Education, 2006), successful implementation of computer programs in schools requires leadership and commitment from all stakeholders. Important variables for the successful implementation of the eConnect and Learn program were: long term planning for computer initiatives with pilot projects; adequate resources for teachers; ways of designing technology-infused curricula for 21st Century teaching and learning; and quality professional development.

Therefore the factors which prompted this study in relation to the other studies discussed were:

- The inconsistency of the distribution of laptop computers to teachers and students differentially.
- A lack of evidence of long term planning.
- The requirement of a more robust professional development plan to provide teachers with the confidence to integrate the laptop computers for pedagogical practice and student learning.

1.8 Approach

At the time of this research, from the period 2012 to 2015, only four studies (Ali, 2013; Briggs, 2013; Onuoha, 2014; Sankar, 2014) had been conducted on the eConnect and Learn program in Trinidad and Tobago. Data from three of the studies were qualitatively analysed whereas one of the studies adopted a quantitative research design. Utilising a mixed methods approach could have presented the opportunity to investigate the project from many angles and different perspectives (Creswell & Clark, 2007). This approach could have provided strengths that offset the weaknesses of the stand-alone research design (Johnson & Onwuegbuzie, 2004) adopted in the four studies. Mixed methods approach has the potential to broaden this research by making comparisons between in-service and pre-service teachers' confidence to use technology. This approach could also enable the investigation of the impact of variables such as: teaching experience, school category, instructional content areas, and qualification on teachers' use of technology as well as explore perceptions of the eConnect and Learn initiative. To provide a deeper insight of the study, a mixed methods approach benchmarked to international standards has the potential to reflect more accurate conclusions and present a more robust study. Therefore a mixed methods approach would have been more appropriate to address the shortcomings of the four previous studies on the eConnect and Learn program.

1.9 Purpose of the Study

At the time of this study in 2013, the eConnect and Learn program had been in schools for over thirty-six months (2010-2013). It was an appropriate time to evaluate how these affordances had been integrated in the learning environment. It was also an opportune time to investigate how confident teachers were in Trinidad and Tobago to make ICT integral to their pedagogical content practices. Certainly, Hattie (2008) has questioned the educational value of just placing computers into schools without a strong induction program and on-going evaluation of the use of technology programs within an educational framework. Williams, Coles, Wilson, Richardson, and Tuson (2000) have also articulated the importance of continuous evaluation when an innovation has been introduced, and to review if there were any unintended consequences associated with the project. Having the knowledge of how teachers integrate the innovation (eConnect and Learn program) and the time taken for full diffusion and implementation would provide valuable information for the evaluation of the program. Implementation in this study refers to the full use of the eConnect and Learn program. Diffusion refers to the time taken for the innovation to be fully used.

1.10 Theoretical Underpinnings for Diffusion of Innovations

The exponential spread of technological innovations, such as computers, the internet and the World Wide Web from the late 20th Century to the early 21st Century has led to expectations of a revolutionary wave for improvement to pedagogy and learning. With the availability and accessibility of these innovations, students are expected to use computers and/or related devices to access information for research, solve problems, make decisions, and construct new knowledge (Finger, Russel, Jamieson-Proctor, & Russel, 2007). These expectations are normally determined by the way teachers utilise the computers and related devices on a micro level (on an individual basis) and on a macro level (school wide basis). Utilisation of the integration of these technological devices depends on the rate of diffusion and full implementation, which in turn is dependent on continuous evaluation of how the innovation is being used. Evaluation results need to be communicated to the users, administrators, and other stakeholders so that relevant changes can be made for optimum diffusion and use of the innovation. Theoretical viewpoints on diffusion, implementation, and evaluation of innovations were enunciated by Rogers (1993) and Hall and Hord (1987).

Rogers (1993, p. 5) defined diffusion as a process by which "an innovation is communicated through certain channels over time among the members of a social system." He viewed diffusion of an innovation as one part of a larger process that begins with a perceived problem or need. Such an example was the need to introduce a computer project or program in schools to support students, such as, in the development of competencies in Information Communication Technologies and Design and Technology (Australian Curriculum and Assessment Reporting Authority [ACARA], 2014). This need was required to prepare students to eventually join the workforce in the present global, knowledge based economy. Before the need for the innovation was introduced, the need ought to have been researched and a possible solution should have been obtained through a change agency. Decisions and activities should be undertaken before the diffusion of the innovation commenced. According to Rogers, (1993), uncertainty may occur in the process if information about the innovation was not communicated clearly to everyone involve in the diffusion and implementation process. Concerns such as “feelings, perception, worries, preoccupation, and moments of satisfaction” need to have been addressed (Hall & Hord, 2011, p. 55). If not, this could have led to resistance and rejection of the innovation.

Rogers (1993) and Hall and Hord (2001) posited diffusion of innovations required a lengthy period, from the time it was introduced in the organisation to the time when it was widely implemented. Therefore, a common problem for many individuals, administrators, and organisations was how to speed up the rate of diffusion of the innovation. Variables which influence the process might be: centralised or decentralised agencies; the level of support; adequate resources; appropriate infrastructure; degree of affluence; customs and values of the country.

A centralised body such as the Ministry of Finance may decide to introduce an innovation in schools. This is termed a top-bottom system where a few individuals are responsible for policy making. Decision of such policies may include: when will the innovation be introduced; what channels will be used for it to be diffused; what resources and infrastructure will be provided; and how, and who, will evaluate the rate of diffusion. Decisions to these questions need many channels and if not communicated clearly, then there is a possibility the diffusion process may take a long time. On the other hand when a decentralised agency, such as, the administrator of a school introduces an innovation, most likely there would be a shared vision by potential adopters: teachers, parents, students, and other stakeholders (Hall & Hord, 2011). The channels for diffusion are not as elaborate as in the centralised system. Communication of diffusion can be informal and linear. As new ideas developed, they could be easily communicated informally and horizontally by potential adopters and thus reduce the time taken for diffusion.

The diffusion process may encounter challenges. For example, emerging educational technology may pose problems to set up boundaries to determine when the innovation is fully implemented in the environment. Another challenge is the type of agency responsible for the diffusion and implementation of the innovation. Does the agency practice bureaucracy or democracy in allowing potential adopters to trial and experiment with the innovation? Will the agency provide adequate knowledge to reduce the complexity of the innovation and develop confidence and trust to make a decision to use the innovation? How is evaluation conducted? According to Hall and Hord (2011) and Moersch (2010), diagnostic evaluation of the stage the innovation has diffused can be measured by observing the way adopters use it in their environment.

The extent of willingness, interest, enthusiasm, and motivation are indicators for the rate of diffusion. For example, if the innovation is being left alone and there is no motivation to use the innovation, then administrators and policy makers from decentralised and centralised systems respectively need to re-evaluate the process of attempting to implement the innovation. Feedback, insights, and understanding from the evaluation process should be analysed and communicated with those involved in utilising the innovation. Collaborative decision-making is necessary to promote the adoption, diffusion, and implementation of the innovation.

1.11 Objectives of the Research

According to Cuban (2001) some teachers transformed technology to fit their existing pedagogy and the needs of their students. They used their same practices and adapted the technology of the day to fit their existing teaching methodologies. These two sentences raise many concerns relating to ICT integration. Teachers may not have the knowledge and confidence to integrate technology in their curriculum activities.

Teachers may learn about the functionalities of computers rather than the integration of ICT for pedagogical content knowledge. In some cases teachers may have the knowledge and confidence to integrate ICT for teaching and learning but there may be inadequate and inappropriate resources to complete tasks. Cuban claimed sometimes teachers who have been working in schools for a long period of time are in their comfort zone and may resist changes to any innovations that they think may pose challenges to their teaching. In addition to this, the school's climate may not encourage a high level of technology integration.

Cuban's analysis of technology integration can be related to some of the results of four studies conducted on the eConnect and Learn program (Ali, 2013; Briggs, 2013; Onuoha, 2014; Sankar, 2014). The results indicated the laptop computers embellished teachers' pedagogical practices but did not influence technology integration for curriculum activities. In fact, the infusion of the program fell below expectations. These viewpoints, together with the factors in Section 1.7 which prompted this study, led to the formulation of three general aims for this research.

1. What factors influence teachers' capacity to integrate ICT with their teaching and student learning?
2. What is the comparison of Trinidad and Tobago teachers' technology integration on an international level?
3. What theoretical implications are there for the future delivery of the eConnect and Learn program?

1.12 Significance of the Study

This study has the potential to produce evidence-based research related to in-service teachers and pre-service teachers' confidence for ICT integration. The results of this study can be used as base-line data to stimulate and expand further research in the implementation of new and emerging ICT projects in educational environments. Existing policies such as the eConnect and Learn policy (MOE, 2010a) and the ICT Professional Development Implementation Plan for Educators in Trinidad and Tobago (MOE, 2010b) can be strengthened from the results and analyses of this research. The policy and plan are described further in Chapter 5.

1.13 Organisation of the Chapters

This thesis is organized in six chapters. The first, Chapter 1: Introduction, sets the stage for the other six chapters. Chapter 2: Literature Review, positions the study within the context of the relevant research. It presents a review of the academic literature in regards to ICT and the eConnect and Learn program. This chapter posits the construction of a new model to add to the corpus of ICT knowledge. Chapter 3: Methodology, describes and clarifies the methods used for the research and outlines the developmental phase of the study. Chapter 4: Results, presents the results for each research question. Chapter 5: Discussion, outlines the findings which are followed by a discussion of the findings for each research question. A new framework extends the prototype model from Chapter 3 to promote 21st Century skills, and evaluate teachers' use of any technology program. Finally, Chapter 6 concludes the study.

1.14 Summary of Chapter 1

Chapter 1 gives an oversight of the research and introduced Trinidad and Tobago from a national perspective in terms of its history, education system and ICT initiatives with emphasis on the eConnect and Learn program. On an international level comparison was made with Australia focussing on bilateral relationships and educational systems. The approach, purpose of the study, objectives of the research, significance of the study and the organisation of the six chapters in this thesis were presented.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The literature review examined current research related to teachers' integration of ICT in a global context. The main areas of focus were the theoretical underpinnings for understanding teaching and learning with computers; the global context for 1:1 computers in schools with emphasis on the eConnect and Learn program in Trinidad and Tobago; and scholarly literature associated with research into these contexts. It was argued in this literature review that Technological Pedagogical Content Knowledge and Levels of Teaching Innovation were the key methods of evaluating teachers' ICT capabilities. In the process a Learning Environment Model, based on strong theoretical underpinnings, was constructed to support the eConnect and Learn program.

2.2 Information and Communications Technology

Gilder, Moore, and Metcalfe's Law (Pinto, 2002) demonstrated the rapid advancement of information technology from the late twentieth century to the early twenty-first century. With the advent of the internet, the World Wide Web, and the improvement of social media, the term "Information Technology" (IT) was merged with telecommunications into the more modern terminology, "Information and Communications Technology" (ICT) (Alexander, 2008). In Europe, "Informatics" is used instead of ICT. Informatics is considered as a science behind information technology with its own concepts, methods, and corpus of knowledge (Association for Computing Machinery, 2015). Another area for consideration when discussing ICT is digital technology. This includes the following: design; technologies which enhance students' design thinking; and technologies for generating and producing designed solutions for current, authentic, and future needs and opportunities. Computational and design thinking, as well as technical skills enhance the creation of solutions and information (ACARA, 2014). Scholars sometimes refer to ICT and digital technology as just technology, particularly in the United States of America.

On a broader basis, technology refers to all the technologies and their emerging devices involved in the management and processing of information systems. For example, some of the technological devices most prominent in the educational sector are computers, mobile phones, digital and document cameras, plasma screens, digital video recorders, interactive whiteboards (Finger et al., 2013), iPads, and web-based resources, such as the World Wide Web, blogs, podcasts, and wikis. Teachers should be educated appropriately to integrate these devices for rethinking and adapting the curriculum for 21st Century teaching and learning on a local, national and international level. Also frameworks are being developed to promote sustainable changes in pedagogical practices as well as to evaluate ICT application and integration in educational institutions (Cerratto-Pargman, Järvelä, & Milrad, 2012; Mishra & Koehler, 2009; Rodríguez, Nussbaum, & Dombrovskaia, 2012).

2.3 Exploring ICT Frameworks

An appropriate ICT framework was sought for this study. Five fundamental elements were integral for the selection process: a clearer vision for integrating ICT in the context of the learning environment; a stronger theoretical underpinning (Burkhardt & Schoenfeld, 2003); a more efficient implementation model which can be planned for, implemented, evaluated, and documented (Laurillard, 2007); greater opportunities for generating further research (Roblyer, 2005); and more flexibility to accommodate the rapid changes in technology and divergences in classroom pedagogy to facilitate 21st

Century learning (Apple Classroom for Today-Tomorrow [ACOT2], 2008). Four frameworks were investigated for these characteristics: ICT for Education (Rodríguez et al., 2012); the NCCA-ICT Framework (National Council for Curriculum and Assessment [NCCA], 2007); Substitution Augmentation Modification Redefinition Model (Puentedura, 2009); and Technological Pedagogical Content Knowledge (Mishra & Koehler, 2009). These four frameworks were examined first followed by the selection of the most appropriate framework for this study.

2.3.1 ICT for Education (ICT4E).

The first framework, ICT for Education (Rodríguez et al., 2012), also known as ICT4E, described an educational program based on the integration of technology enhanced learning (TEL) environment into teaching and learning practices. The model was evidence-based and was designed to determine its ability to enhance improvements before evaluating its results. This was termed the pedagogic model because it focused on modifying teaching and learning in ways that were impossible without ICT support. Four attributes were assigned to each process:

- Setting - which referred to where the process operates such as in the classroom, school or external area.
- Time - indicated the duration of the process.
- Outcomes - included expected skills and/or practices to be developed by students, teachers, and school staff.
- The aim of the process - included: implementation, intervention, transference, and costs.

Implementation: This is a set of methodological strategies (explicit improvement goals) supported by a TEL environment. It included the development of new skills for teachers, trainers, and students within an educational context based on teaching and learning theories and models. Its implementation outcomes consisted of expected effects in terms of scores from standardised testing, learning of specific curricular contents, and acquisition of 21st Century skills.

Intervention: This includes the development of skills and practices for school staff. This was monitored and evaluated by an external team responsible for training and to ensure the adoption of the pedagogic model.

Transference: An external support team acquired professional training to ensure the intervention was carried out on a massive scale.

Costs: This included the total cost of implementation, intervention, and transference for the duration of the programme.

These attributes were integral in the contribution of policy development for educational technology and evaluating the effectiveness and scalability (implementation of the innovation to large numbers of classrooms and schools) of a technology initiative in Chile (Rodríguez et al., 2012).

2.3.2 The NCCA-ICT framework.

The NCCA-ICT framework (NCCA, 2007) was developed to provide a structured approach to curriculum and assessment in Ireland. Its foundation was constructed on four tenets: creating, communicating and collaborating; thinking critically and creatively; developing foundational knowledge, skills and concepts; and understanding the social and personal impact of ICT. Each had three progressive levels outlining what teachers should teach and what students ought to learn. This framework was used as a tool to help teachers integrate ICT purposefully and appropriately for teaching and learning across curriculum subjects. Support was given by the Assessment, Curriculum and Teaching Innovation on the Net (http://action.ncca.ie/).

2.3.3 SAMR Framework.

A third framework, Substitution Augmentation Modification Redefinition (SAMR) Model (Puentedura, 2009) aimed to ensure educators develop effective pedagogy through technology. This framework was similar to the NCCA-ICT model because they were built on progressive levels of the use of technology in the educational environment. Four levels were outlined in the SAMR model:

Substitution: The learning environment was more teacher-centred without the integration of any form of technology.

Augmentation: Computer technology had penetrated pedagogical practices at a low level.

Modification: The classroom was transformed to facilitate the integration of technology.

Redefinition: Prior inconceivable tasks were now made possible with new ways of teaching and learning with technology.

It was expected as the importance of technology increased, its visibility decreased along the teaching and learning continuum in this framework.

2.3.4 TPACK framework.

Unlike the first three frameworks, the fourth was designed from the dynamic transactional relationships of three educational knowledge domains: content, pedagogy, and technology. This is described as the TPACK framework which demonstrated the basis of constructing “good teaching with technology” (Mishra & Koehler, 2006, p. 1029). It explored teachers’ understanding of how ICT can be used as an integral pedagogical tool in the process of teaching and learning. Its theoretical underpinnings emerged from learning theories based on constructivism and differentiated teaching and learning (Engeström, 1999; Vygotsky, 1978).

2.3.5 Selection of the most appropriate framework

The four ICT frameworks had a vision for integrating ICT in the context of the learning environment. They articulated flexibility to changes in technology which impacted on changes in pedagogy. The ICT4E framework responded to the enhanced learning environment through the design of a technology program, Eduinnova (Rodríguez et al., 2012). Its transference component allowed the program to be implemented in schools in Argentina, Brazil, Guatemala, Britain and the United States of America. This framework, unlike the other three frameworks, allowed for a more accurate estimation of the cost of integrating ICT programs at every level of the education system. The NCCA-ICT framework provided learning opportunities for teachers and students from only primary schools in the three levels of ICT integration. The SAMR framework was more explicit in the application of technology from primary to tertiary levels. In contrast, the TPACK framework demonstrated more rigor than the other three because it provided opportunities for further research and was a foundation for building teachers' confidence to integrate ICT in their teaching and students' learning (Graham et al., 2009; Jamieson-Proctor et al., 2013).

The TPACK framework has generated global interest as a powerful conceptual tool for educators to communicate with a common language for research and curriculum design. Unlike the ICT4E, NCCA-ICT, and the SAMR framework, the TPACK model has widely penetrated scholarship in the use of teacher preparation, professional development, pedagogical practices, online learning, and teaching. Additionally, it is used as a lens to facilitate research designs such as qualitative and quantitative methodologies (Altun, 2013; Koh & Divaharan, 2013; Lloyd, 2013; Schmidt et al., 2009). Among the studies related to the four frameworks, the TPACK model captures all the criteria for suitability for selection and therefore is foregrounded to shape this study.

2.4 Description of the TPACK Framework

Proponents of ICT use have recommended ‘the what,’ that is what teaching and learning strategies enhance the learning process before the selection of ‘the which,’ that is which technologies best support those practices (ACOT2, 2008; Schmidt et al., 2009). To make these decisions possible, educators should have the confidence to integrate appropriate educational technology with their pedagogical practices in the delivery of content knowledge. A number of studies articulated a lack of confidence in this area.

A study conducted by Finger, Jamieson-Proctor, and Albion (2010) revealed two out of every five students leaving teacher education programs at two universities in Australia had no confidence or just some confidence to integrate ICT for teaching and learning. The study reported that although pre-service teachers used digital technologies in their personal lives on a daily basis, they failed to connect this technological knowledge in the preparation of their own teaching. Another study conducted by Lloyd (2013, p. 1) articulated:

> Much of our experience to date in the schooling sector tells more of resistance and reaction than the revolution, of more of the same but with a computer in the corner and of ICT activities as unwelcome time-fillers/time-wasters.

The two studies demonstrated a level of tension between teachers’ desire to integrate ICT into their pedagogical practices, and teachers’ confidence to have the knowledge, skills, and abilities to utilise appropriate technologies to make learning more stimulating and challenging in the learning environment. The tension can be gradually diminished as teachers learn how to construct, understand, and better apply their technological pedagogical content knowledge to their pedagogical practices. The TPACK framework consists of the integration of three knowledge domains: technology, pedagogy, and content (Mishra & Koehler, 2009). Application of this integration could help empower teachers to plan the content they teach, to better develop the pedagogical strategies they need to underpin how and what students learn, and to better access and use appropriate ICT in contemporary educational settings.

The TPACK framework was constructed from Shulman (1986) seminal work on pedagogical content knowledge (PCK) with the integration of technological knowledge. PCK is the integration of two knowledge domains, content knowledge (CK) and pedagogical knowledge (PK). Recent proponents in the early twenty first century believe that there is a defining characteristic of technological knowledge (TK) in its relationship to Shulman's PCK (Angeli & Valanides, 2009; Mishra & Koehler, 2008; Niess, 2005). The synergy of the integration of the three knowledge domains is illustrated in Figure 5.

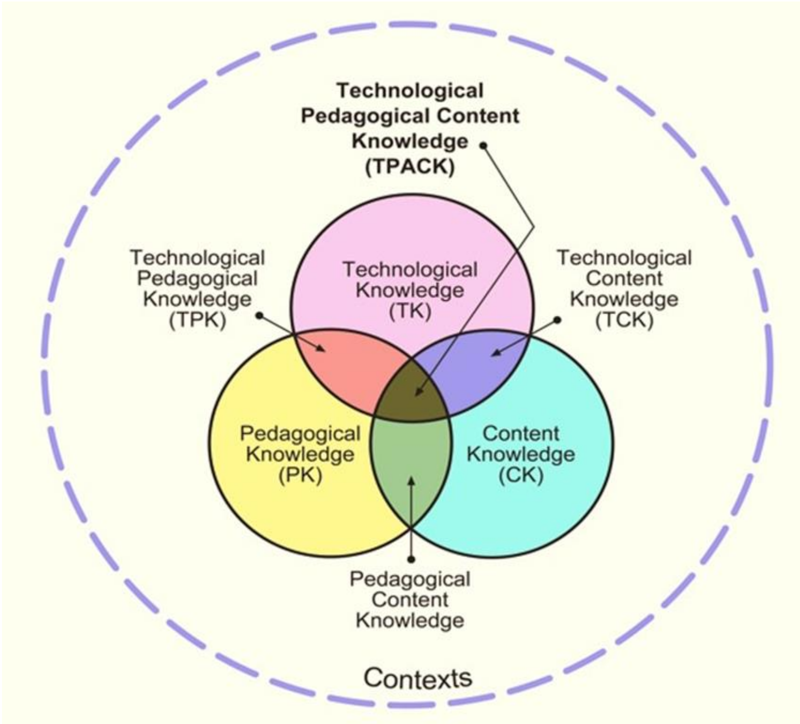


Figure 5. TPACK framework as outlined by Mishra and Koehler (2008).

Figure 5 demonstrates the integration of the knowledge domains, technology, pedagogy, and content, which intersect to produce four new subsets: pedagogical content knowledge (PCK- integration of pedagogy and content); technological pedagogical knowledge (TPK- integration of technology and pedagogy); technological content knowledge (TCK- integration of technology and content); and technological pedagogical content knowledge (TPCK- integration of PCK, TPK, and TCK). An 'A' was inserted in TPCK for better pronunciation (TPACK) and to indicate that it is a 'Total PACKage' for teaching with technology (Thompson & Mishra, 2007-2008). Since the TPACK subset was common to all the other subsets in the framework, the term TPACK framework was established. The three domains and their subsets, termed constructs, were fundamental in understanding appropriate ways of integrating technology in the learning environment. This understanding has the potential to build teachers' confidence to plan activities and transform learning in innovative and creative ways. The importance of each component of the TPACK framework is outlined.

Content knowledge (CK): Shulman (1986) articulated that CK involves the theories, principles and concepts of a particular discipline. With the rapid increase of access to current information, educators should think about emerging content areas. Concepts in different content areas can be organized into themes in their subject areas and could be retrieved when they are needed quickly and with little effort (Bransford, Brown, & Cocking, 1999). In addition content delivery is not only memorising facts and applying skills but positioning it to problem situations interwoven across interdisciplinary themes to increase the relevance for today's learners (Casner-Lotto & Barrington, 2006).

Pedagogical knowledge (PK): This knowledge domain focusses on a host of teaching processes. Teachers should understand subject matter deeply and flexibly in order to facilitate students' construction of their own learning and clarification of any misconceptions relating to the topics to be taught (Shulman, 1986). Pedagogy and technologies for learning have a close relationship and therefore the scope and style of pedagogy change as technology changes. The number of learning technologies, beyond the classroom and away from the teacher, provides the opportunities of opening a new schema for education. Educators should constantly be rethinking the style and scope of pedagogy as the digital age continues to create challenges with new and emerging technologies (Beetham & Sharpe, 2013).

Technological Knowledge (TK): This knowledge domain focuses on the manipulation, application and integration of technological devices to transform learning in more innovative and creative ways in specific disciplines, interdisciplinary and multi-disciplinary approaches (Angeli & Valanides, 2009; Finger et al., 2007; Mishra & Koehler, 2006).

Pedagogical Content Knowledge (PCK): When teachers integrate content knowledge and pedagogical knowledge in the preparation of delivering curriculum activities, a new construct, pedagogical content knowledge, emerges. Shulman (1986, p. 8) discussed this emergence of new knowledge as an understanding of "how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and are presented for instruction."

Technological content knowledge (TCK): This refers to the knowledge of how technology can be used to create new representations and transformations for specific content. Educators should understand that by using an appropriate and specific technology, they could change the way learners (especially those with varying learning abilities) practice and conceptualize specific content goals and objectives (Mishra & Koehler, 2006).

Technological pedagogical knowledge (TPK): This refers to how teaching methods might change as a result of using particular technologies. Mishra and Koehler (2008, p. 1028) articulated:

> This might include an understanding that a range of tools exists for a particular task, the ability to choose a tool based on its fitness, strategies for using the tools' affordances, and knowledge of pedagogical strategies and the ability to apply those strategies for use of technologies.

Technological pedagogical content knowledge (TPACK): This refers to the knowledge required by teachers for integrating technology into their teaching in specific disciplines, interdisciplinary or multidisciplinary content and pedagogical areas. TPACK is an integrative understanding of the three knowledge domains: content, pedagogy and technology. It includes the most useful forms of representing and

> communicating content in constructive ways for students to comprehend specific concepts and topics of a discipline or disciplines with the use of technology. It encompasses theories of epistemology, and includes knowledge of how appropriate technologies can be utilised to build on existing knowledge and consequently 'to develop new epistemologies or strengthened old ones' (Mishra & Koehler, 2008, pp. 17-18).

There is a chain reaction as new pedagogical technologies emerge. Teachers could be significantly influenced to make changes in their mode of delivery of instruction as content becomes more accessible. Students in turn could develop new ways to construct their own thinking and explore different avenues to acquire and conceptualize new knowledge in the real-time of the world in which they live. Hence the importance of research in the integration of content, pedagogy, and technology (TPACK) should be given prominence in the educational environment.

2.4.2 Application of TPACK.

Components of the TPACK framework were applicable in projects designed to challenge learning in the 21st Century (Voogt, Fisser, Pareja, Tondeur, & van Braak, 2012). Three programs were described to reflect the applicability of the embedded constructs of the framework, labelled in parentheses. The first is described by the Computer-Supported Intentional Learning Environments (CSILE) project from the University of Toronto (Scardamalia & Bereiter, 1999). Students were invited into a 'knowledge-building environment' where they entered concepts and related information (TK and CK) into a shared database (TCK). Following this, the concepts were refined into researchable questions (PCK) through a series of scaffolded interactions contributed by others (PK, TPK, TCK), and aided by prompts provided by the software

(TPACK). Although CSILE is still available as a Knowledge Forum, many of the functionalities of the ‘knowledge building environment’ can be duplicated using Web 2.0 technologies such as wikis and blogs (TPACK).

The second program was the Teaching Teachers for the Future project in Australia. Constructs of the TPACK framework were utilised in the development of the ‘anywhere, anytime’ national digital resources and were available online for educators at http://www.ttf.edu.au (Finger et al., 2013). These resources focus on the Australian Curriculum for English, mathematics, science, and history. For example, the three packages developed for teaching science demonstrate the powerful intersection between the Australian Curriculum for science (CK), the pedagogy for teaching science (PK, PCK), and the appropriate ICT (TK, TCK, TPK) to be used. Emphasis has been given to incorporate ICT design projects (TPACK) as platforms to help teachers develop connection and integration between TK, PK, and CK (Mishra & Koehler, 2006; Niess, 2005).

Thirdly, the TPACK framework is also embedded in the integration of technology (TK) with scientific, engineering, and mathematical concepts known as STEM education (Sanders, 2009). The STEM education approach is used to merge several single disciplinary domains using appropriate technology (PCK, TCK, and TPK) for related subject areas. This is also applicable to other non-scientific domains: for example, social studies, the arts and humanities can be integrated with science and technology (PCK) for the delivery of instructions. This approach attempts to bring the practical experiences from outside the classroom into the classroom (TPACK) through design and scientific inquiry for the 21st Century (http://www.stem.ed.qut.edu.au/).

All the projects described above captured the applicability of the TPACK framework and suggest its affordances for students and teachers to collaborate effectively to construct learning. These projects could also enhance students' thinking skills and knowledge for the 21st Century. The learning environment provides an avenue for transforming the way teachers deliver instructions as well as creating new approaches for passive students to become active learners. Learning strategies, such as constructing knowledge, inquiry-based learning, differentiating teaching and learning, social communication, and progressive problem solving (scaffolding) were embedded in the projects.

2.4.6 Usefulness of the TPACK framework.

Attention should also be given to the versatility and multifaceted use of the TPACK framework. To date it has been utilised for designing, implementing and evaluating curriculum and instruction courses relating to ICT integration for pre-service, in-service, and university lecturers (Angeli & Valanides, 2009; Chai, Koh, & Tsai, 2010; Finger et al., 2013). Survey instruments were designed and validated to measure pre-service and in-service teachers' TPACK (Jamieson-Proctor et al., 2013; Schmidt et al., 2009). What was interesting, the framework was also instrumental in evaluating face-to-face as well as online courses (Anderson, Barham, & Northcote, 2013; Benson & Ward, 2013; Valtonen, Kukkonen, & Wulff, 2006). The TPACK framework enabled educators to develop a better understanding of the dynamic interaction among the "three core components: content, pedagogy and technology, and the relationships between them" (Mishra & Koehler, 2008, pp. 11-12). Table 2 summarises eight studies describing each research project and its country of origin, research designs, and main findings conducted globally on constructs of the TPACK Framework.

Table 2

Usefulness of the TPACK Framework

Authors	Research	Methodology	Findings
Anderson, Barham, and Northcote (2013) from Australia.	1. Rationale for 15 lecturers to use various technologies and teaching strategies. 2. The extent to which different elements of teacher knowledge were evident in online teaching as well as in the blending learning environment.	Qualitative. The TPACK framework was used to analyse semi-structured interviews.	1. Participants had adequate PK and TK to choose appropriate technologies and reconfigure them according to changes in context and purposes. 2. CK, PK and TK were not in isolation but PK and TK were more dominant than CK.
Benson and Ward (2013) from the USA.	Using the TPACK framework to investigate teacher knowledge present in pedagogical approaches of three lecturers.	Qualitative. The TPACK framework was used graphically.	Two lecturers had more CK and TK and less PK. The third lecturer had more CK and PK but less TK. TPK, TCK, PCK was very small. One lecturer had little TPACK.
Altun (2013) from Turkey.	Examination of classroom teachers'TPACK on the basis of their demographic profiles.	Quantitative. Independent *t*-test, ANOVA and Mann Whitney U tests were conducted.	Meaningful relationships and significant differences existed between the variables for gender; internet access, use of an ICT lab in the school; use of educational software and the sub-factors of the TPACK scale.
Schmidt et al. (2009) from the USA.	Development and validation of an assessment instrument for pre-service teachers.	Quantitative.	Factor loadings of the seven constructs ranged from .59 to .92. Good internal consistency was achieved for each construct where α was above .75.
Angeli and Valanides, (2009) from Cyprus.	Self, peer, and expert assessment of design-based performances for assessment of teachers' understanding of TPACK.	Quantitative.	Theoretical models proposed can positively impact the development of ICT-TPCK.
Jamieson-Proctor et al. (2013) from Australia.	Construction and validation of a TPACK survey instrument with TPK and TCK on one dimension and TPACK on another for two scales: usefulness and confidence.	Quantitative.	Cronbach's reliability coefficient (α) of: Confidence for TPK/TCK, α = .97. Usefulness for TPK/TCK, α = .97. Confidence for TPACK, α = .99. Usefulness for TPACK, α = .98.

Authors	Research	Methodology	Findings
Archambault and Crippen, (2009) from the USA.	Examined TPACK among K-12 online educators in the United States.	Quantitative.	Low correlation between TK and PK, r = .29 ;TK and CK, r = .32. High Correlation between PK and CK, r = .69.
Liang, Chai, Koh, Yang, and Tsai, (2013) fromTaiwan.	To develop and utilize the TPACK survey to investigate in-service preschool teachers' TPACK.	Quantitative. TPK and TCK constructs were combined on one scale (TPTCK).	Cronbach's reliability coefficient: TK, α = .92; CK, α = .87; PK, α = .88; PCK, α = .94; TPTCK, α = .94 and TPACK, α = .91 Preschool in-service teachers with longer years of teaching service were less knowledgeable about technology and technology integration. Pre-school in-service teachers who had higher qualifications tend to have better competencies in the application of technology and ICT integration

Note: r indicates correlation. α indicates Cronbach's alpha coefficient.

Through interrogation of the eight studies, it can be argued the TPACK framework was integral for research and pedagogical purposes along a continuum from pre-school to tertiary levels. In addition, it was an important platform for conducting quantitative and qualitative studies (Benson & Ward, 2013; Jamieson-Proctor et al., 2013). On the other hand a review of the literature found some studies had challenges with the TPACK framework.

2.5 Challenges of the TPACK Framework

This section of the literature review discusses challenges encountered with the constructs of the TPACK framework. According to Graham (2011), there is variation in the understanding of TPACK and therefore different appendages were used. For example, Angeli and Valanides (2009) used ICT- TPACK as a strand of TPACK. Liang, Chai, Koh, Yang, and Tsai (2013) merged TPK and TCK items on one subscale, TPTCK. Lee and Tsai (2010) used TPCK-W to assess teachers' self-efficacy relating to utilisation of the Web in teaching. Reports also indicated there were problems with the validity and reliability of survey instruments.

Koehler, Shin, and Mishra (2012) categorised 141 instruments relating to the TPACK assessments, published during the period 2006 to 2010, into five groups: self-report measures, open-ended questionnaires, performance assessments, interviews, and observations. An investigation was undertaken to capture how each measure addressed the issues of validity and reliability. Findings revealed the self-reported measures had the highest number of studies for reliability and validity. Open ended questionnaires, performance assessment, and observations presented evidence of reliability and only two studies expressed validity. No studies in the interview category established both reliability and validity.

Similar studies had challenges with the construct validity of TPACK surveys (Archambault & Barnett, 2010; Chai, Koh, & Tsai, 2013; Graham et al., 2009; Schmidt et al., 2009). Graham et al. (2009) designed a content specific survey for TPACK but it was a survey that focused on eight pedagogical uses of ICT for teaching science. It was pilot tested with only 15 teachers, a sample that was insufficient to produce accurate statistical construct validation (Chai et al., 2010). In another study exploratory factor analysis of the TPACK survey for online teaching produced items for CK, PK and PCK loaded as one factor and items for TPK, TCK, and TPACK loaded as another (Archambault & Barnett, 2010). Lee and Tsai (2010) isolated the factors of TK, TPK, TCK, and TPACK, but found two items, PK and PCK were loaded as one factor. The study by Liang et al. (2013) produced only one factor loaded on the TPK and TCK items.

Rapid changes in educational technology can contribute to the differences in reliability and validity of the TPACK domains. Additionally, differences in the research design can give rise to varying conclusions in the TPACK domains (Angeli & Valanides, 2009; Archambault & Crippen, 2009; Lee & Tsai, 2010). In some cases, professional development focussed on technological knowledge, introducing teachers to new hardware and/or software applications, without considerations of context, pedagogy and content (Jamieson-Proctor, Finger, & Albion, 2010). The relationships between the factor constructs of TPK, TCK, TK in relation to the TPACK factor construct may not necessarily be the same when different cohorts of students and others complete the surveys. Even though the same surveys may still operate on “ambiguous preconditions regarding the validity of TPACK self-report measures” (Krauskopf & Forssell, 2013 p. 2190). Attention will now be focussed on the 1:1 computer programs.

2.6 Global Perspective of the 1:1 Computer Programs

This section examines ICT implementation, affordances, constraints, and evaluates school supported technology programs. One such program in which each student is provided with a laptop computer to be used at school and at home was termed the 1:1 ratio program (Bate, Macnish, & Males, 2012; Oppenheimer, 2003). Another program with a similar terminology was the 1:1 ratio computing. This term referred to one student who has access to one technological mobile device, such as a laptop computer, a netbook, a tablet computer or a smartphone (Richardson et al., 2013). Finally there was the one laptop per child (OLPC) program which consists of low cost computers such as XO laptops, Classmate PCs, and net books (Negroponte, 2006; Zucker & Light, 2009).

The first school to introduce the 1:1 ratio computing for Grades 5 to 12 in Australia was the independent Methodist Ladies Presbyterian College in Melbourne in 1989 (Stager, 1998). It was not until 2009 with the Digital Education Revolution policy, that laptop computers were provided to Australian students in Years 9 to 12 (Rudd, Smith, & Conroy, 2007). On the opposite side of the globe, over 1,000 school districts in the United States of America purchased approximately 150,000 laptop computers in an effort to introduce the 1:1 program in the year 2000 (Johnstone, 2003; Oppenheimer, 2003; Silvernail & Lane, 2004). A similar initiative, the Emerge One-to-One Laptop Learning Project, began in Alberta, Canada in 2006. A total of 2,502 students, 173 teachers, and 47 administrators within 50 schools in its 20 jurisdictions were involved in the program. South of the USA, Latin American countries (LAC) and the Caribbean, such as Argentina, Brazil, Chile, Peru, Uruguay, Haiti, Jamaica, Barbados, and Trinidad and Tobago (Gopeesingh, 2010a; Severin & Capota, 2011; Valente, 2012) adopted the 1:1 program from 2006 to 2010. Apparently the 1:1 laptop computers had sparked interest in many parts of the world.

Studies were conducted to evaluate the success or failure of the 1:1 laptop program by teacher-made tests and standardized scores in many countries (Bebell & Kay, 2010; Cristia, Ibarrarán, Cueto, Santiago, & Severín, 2012; Holcomb, 2009; Lei & Zhao, 2008). Test scores in English Language Arts (ELA) were investigated from two different groups of students in California (Suhr, Hernandez, Grimes, & Warschauer, 2010). Results revealed there were higher scores in one group exposed to learning with the integration of the 1:1 program. Lower scores were achieved by students who had no experience with computer programs. Similar studies across the United States found remarkable gains in scores in subject areas such as English, Mathematics, Science, and technology skills with students exposed to learning in the 1:1 program (Bebell & Kay, 2010; Holcomb, 2009; Lei & Zhao, 2008). Studies similar to these were supported by analysis of data collected on the performance of students in Peru using the XO laptops at home and at school (Negroponte, 2006). Students performed better on the Raven's

Progressive Matrices test than students who did not have a home computer (Severin & Capota, 2011).

Using students' performance in standardized tests to evaluate the 1:1 laptop programs was debated rigorously in the literature review conducted by New South Wales, Australia (Digital Education Revolution, 2010). Suhr et al., (2010) argued although standardized tests measured only a facet of the curriculum, they were still reliable to indicate achievement but Rutledge, Duran, and Carroll-Miranda (2007) questioned if measuring the success of the 1:1 program by this type of testing is appropriate. Good teaching can bring about increased test scores but having access to more information with the laptop programs, and the way this knowledge is synthesised to construct new knowledge can also contribute to higher grades.

Reports from Australia, Canada, the United States (Alberta Education, 2006), indicated students were better able to develop 21st Century skills such as decision making and problem solving, improve their literacy writing skills, and increase the quantity and quality of work with the 1:1 programs. In addition, teacher and students' interactions improved; students' attendance was more regular; and there were positive changes in the teaching and learning environment (Silvernail & Lane, 2004). Although technological breakthroughs have produced such positive results, yet there were still concerns for these programs in the educational context. There was a lack of vision for emerging technologies. Sustainability, planning, and relevant evaluation encountered difficulties. The quality of professional development came into question (Alberta Education, 2006; Kraemer, Dedrick, & Sharma, 2009; Penuel, 2006).

Although the 1:1 programs have penetrated scholarship in several continents since the late 20th to the early 21st Century, studies have shown there were constraints within the education system to promote the programs for full success (Ertmer, 1999;

Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Jamieson-Proctor, Watson, Finger, Grimbeek, & Burnett, 2007; Penuel, 2006; Zucker & Hug, 2008). Researchers articulated that success of full implementation of the laptop computer programs depended on a number of variables including quality of professional education and time to practice what was learned (Zucker & Hug, 2008); teachers' attitudes and beliefs (Ertmer, 1999; Ertmer et al., 2012); and provision of appropriate infrastructure, resources, and support (Penuel, 2006).

2.7 Studies Related to the eConnect and Learn Program

Similar results were achieved from four studies conducted from different perspectives on the eConnect and Learn program. Whereas Briggs (2013) explored the usage of the laptop computers, Ali (2013) investigated assessment and impact of the program on students' academic performance. In contrast, the other two studies examined the teachers' perception and perspectives of the program (Onuoha, 2014; Sankar, 2014).

Three of the studies were qualitative in nature and their sample sizes were small. Data collection was mainly through interviews and questionnaires. The participants in the studies varied in number from one to nine teachers; one to three principals; one Dean (Head of Department) and two groups of students from Form 2 (Grade 7, 13 to 14 years of age) and Form 3 (Grade 8, 14 to 15 years of age). The secondary schools in the study included single gender, co-educational, government, and denominational institutions. Only one out of the four studies by Briggs (2013) employed a quantitative research design. The sample size was large with 1,500 students who responded to the survey from 32 secondary schools.

The four studies reported mixed results. Positive results indicated teachers perceived that the eConnect and Learn program enhanced their pedagogical practices and impacted substantially on some disciplines, especially in the technology related areas, such as Information Technology and Computer Science. In contrast, negative results indicated infusion of the eConnect and Learn program for teaching and learning had fallen generally below expectations. The indications were that support from principals and time for collaboration among peers were also limited. Physical infrastructure was inadequately designed to facilitate the full use of the eConnect and Learn program. Teachers' workload prevented sufficient time for planning to use the laptop computers. Reports from the four studies of the eConnect and Learn program indicated the learning environment facilitate minimal dynamic interactions for teachers and students' personal, social and academic practices as had been anticipated by the Minister of Education (Gopeesingh, 2010a).

2.7.1 Limitations of previous studies relating to the eConnect and Learn program.

While these previous research studies into the eConnect and Learn program have identified limitations in the implementation of the program they have not directly investigated the teachers' technological pedagogical content knowledge which is a critical factor in any eLearning content (Niess, 2005). As identified in the literature review there have been developments in measuring and identifying teachers' technological pedagogical content knowledge (Angeli & Valanides, 2009; Mishra & Koehler, 2008; Niess, 2005). Thus it is the core aim of this research to investigate the Trinidad and Tobago eConnect and Learn program in alignment with the Trinidad and Tobago teachers' technological pedagogical content knowledge. To better explore this alignment, it was decided for the purposes of this current study to construct an implementation model that would address some of the concerns raised by Ali (2013); Briggs (2013); Onuoha, 2014; and Sankar (2014). The model is described below as the Learning Environment Model.

2.8 Learning Environment Model (LEM)

The Learning Environment Model (LEM) was constructed from three dimensions. The first dimension originated from the results of the analyses of studies related to the 1:1 laptop programs (Alberta Education, 2006; Kraemer et al., 2009; Penuel, 2006; Zucker & Hug, 2008; Finger et al., 2007). Findings revealed factors, such as teacher support; appropriate infrastructure; professional development; time allocated to practice ICT integration; resources; and collaboration among teachers were required for successful implementation of technology programs. These factors comprised the systems level of the LEM model. The second dimension consisted of the six design principles of the Apple Classrooms of Tomorrow-Today (ACOT2, 2008): informative assessment; creativity and innovation; relevant and applied curriculum; ubiquitous access to technology; understanding 21st Century skills and outcomes; and social and emotional connection with students. Appropriate understanding and application of the systems level and the six design principles in teaching and learning could contribute to critical thinking, metacognitive skills, collaboration and teamwork. These are requisites to underpin 21st Century skills which are the components of the third dimension of LEM. The three dimensions of LEM are integral to a bigger picture of 21st Century teaching and learning which will be discussed in more detail in Chapter Five on page 195 to 199. Figure 6 presents the Learning Environment Model.

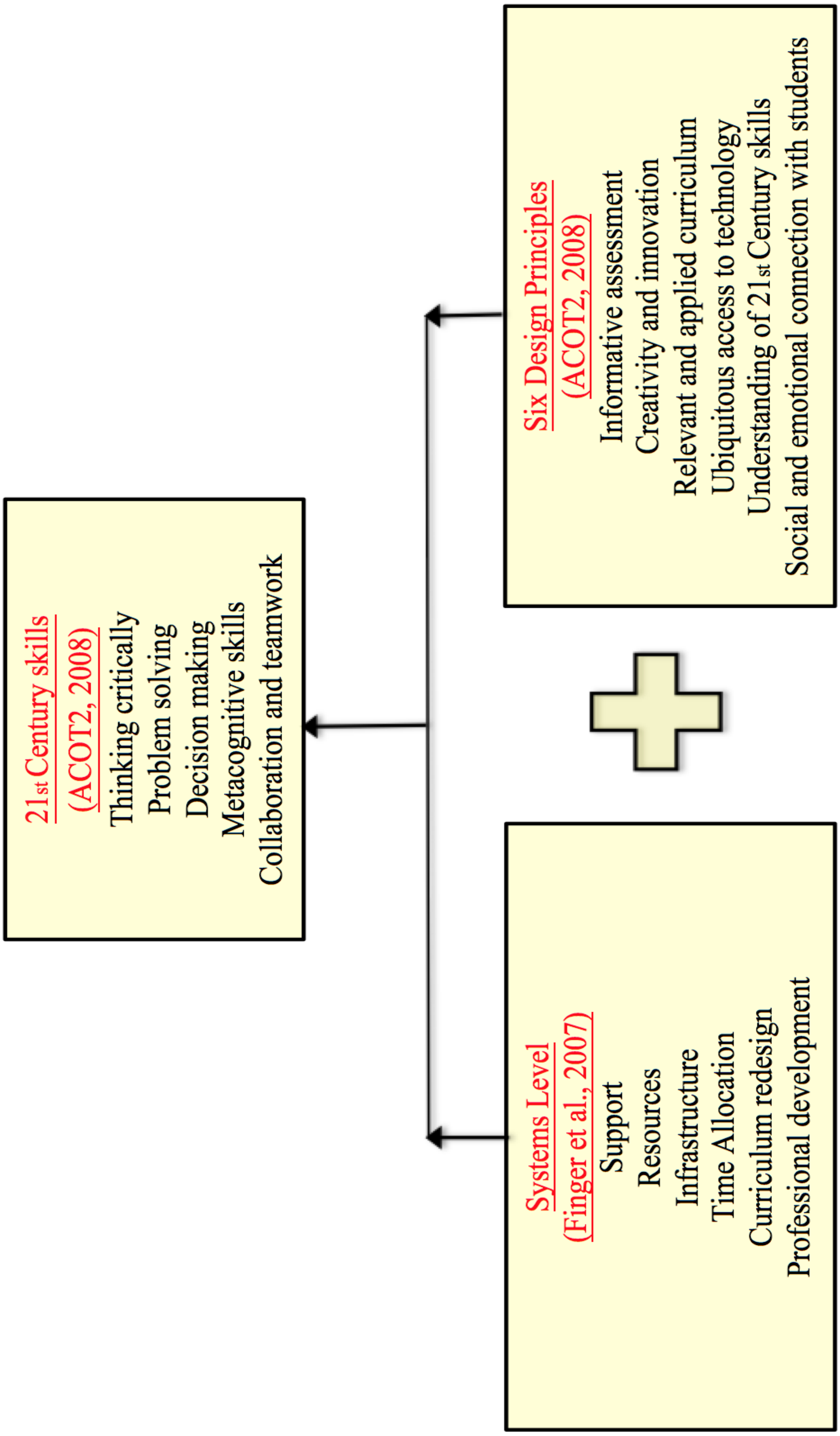


Figure 6. The Learning Environment Model (LEM)

Theoretical underpinnings of LEM are embedded in notions of Activity theory (Engeström, 1999; Leontiev, 1978); the work of Vygotsky (1978); and revised Bloom's Taxonomy (Anderson, 2006). Each of these will be discussed briefly.

2.8.1 Activity theory.

Activity theory (Engeström, 1999; Leontiev, 1978) is important in the educational field because educators and their students' activities are multifaceted, energetic, and "rich" in variations of content and form. The Activity theory reflects this dynamic richness of synergy. It postulates there are a number of factors in an activity and each factor involved in an activity mediates the others to facilitate the activity. The factors in this context are the learners. The objectives are the 21st Century skills. The outcomes are the differences made by the application of the design principles and the systems levels. The framework is the culmination of all the components put together to guide the activity; the social content consists of the classrooms with the stake-holders (teachers and learners).

2.8.2 Vygotsky (1978) Learning and Social Development Theory.

The six design principles which are demonstrated in italics below are further strengthened by Vygotsky (1978) Learning and Social Development Theory which articulates three major themes. The first is the importance of the social environment in the cognitive development of learners. From Vygotsky's point the classrooms are multicultural domains with a number of integrative systems, technological and educational, for the development of cognitive and metacognitive skills. Students move from an individualistic to a sociocultural perspective (Kozulin, Gindis, Ageyev, & Miller, 2003). The fundamental concept to this perspective is demonstrated in the

Ubiquitous Access to Technology. When students and teachers internalise the use of technology, they begin to master their own psychological function of understanding how to integrate the technological tools in the learning environment. Working together will promote *Social and Emotional Connections with student*. These two design principles reflect the sociocultural perspective of Vygotsky's theory.

The second domain of Vygotsky's theory is the more knowledgeable other (MKO) (adult or peers). From Vygotsky's point the cognitive and metacognitive skills can build further skills for interdisciplinary and multidisciplinary areas by mediation of the MKO. This person can be an adult or peer who has a better understanding or a higher ability level than the learner and can guide the transfer of knowledge effectively. Collaboration like this can enhance *Understanding of 21st Century Skills and Outcomes* such as problem solving, critical thinking, project construction and promote a *Culture of Innovation and Creativity*. These two design principles reflect the learning component of Vygotsky's theory.

The third component of Vygotsky's theory is the Student's Zone of Proximal Development (ZPD) (Brown & Ferrara, 1985). This is the distance between a student's ability to perform a task under adult guidance and/or with peer collaboration and the student's ability solving the problem independently. This dimension emphasises the promotion of the learning contexts in which students play an active role in constructing their own learning. Understanding students' ZPD can help teachers make informed decisions of the students' learning styles, learning needs and individual differences. By implementing regular *Informative Assessments* teachers can better know what students need to learn and what approaches they should adopt to adjust the instructions in the *Relevant and Applied Curriculum* to meet the individual needs of the students. These two design principles reflect the constructivist component of Vygotsky's theory.

Teachers' technological pedagogical content knowledge (TPACK) will enable them to plan problem-based and project based learning related to real life activities.

2.8.3 Revised Bloom's Taxonomy.

The revised version of Bloom's Taxonomy focusses on the Constructivist Learning Theory (Anderson, 2006) which is closely related to the development of 21st Century skills in LEM. Anderson argues that students should be active participants in their own learning by selecting information and constructing their own meaning. Because of the explosion of the content via the World Wide Web and the internet, curriculum designers and teachers need to be careful in selecting content as well as how they use eLearning to teach concepts for students to remember, understand, apply, analyse, evaluate, and create new knowledge. These constructivist processes reflect the cognitive dimension of the constructivist learning theory.

The application of the knowledge dimension of the theory, factual, conceptual, procedural, and metacognitive (Anderson & Krathwohl, 2001) are important attributes for teachers and their students. Factual knowledge describes the basic elements students are often require to know to be familiar with a discipline or solve problems within the discipline. Conceptual knowledge is demonstrated during collaboration and teamwork when students can explain the interrelationships of concepts in a discipline or disciplines. Procedural knowledge examines the methods of inquiry and problem solving for using skills, techniques, and methods of accomplishing specific tasks. Metacognitive knowledge examines an awareness of knowledge about one's own cognition.

The cognitive and knowledge dimensions are the foundation for constructing 21st Century skills. The two dimensions need to be understood by teachers for transmitting the processes involve for application by their students to make decisions, solve problems, create and innovate, collaborate, think critically and learn how to learn in our ever-evolving technological world. These are considered as important components to promote 21st Century skills for the present and future knowledge economy.

2.8.4 Constraints of the Learning Environment Model (LEM).

The constraints of the Learning Environment Model (LEM) will be determined by the way teachers choose to organise the learning environment to facilitate the application of the three theories discussed: the Activity theory, Learning and Social Development Theory, and Revised Bloom's Taxonomy. The organisation will depend on teachers' confidence and knowledge of the ICT integration required for their pedagogical practices in the dissemination of content matter. The systems level of LEM has the potential to guide teachers, school administrators and officials from the Department of Education of the factors required to achieve productive teaching and learning for the 21st Century. Furthermore, the six design principles can contribute to effective teaching and learning for the 21st Century. For stakeholders to be successful in the implementation of LEM, they should continuously reflect and evaluate their contribution in the learning environment. Special emphasis should be given on the evaluation of strategies employed for the utilisation of technological pedagogical content knowledge in the classrooms. A pedagogical model known as the Levels of Teaching Innovation developed by Moersch (2010) could benchmark teaching strategies for the 21st Century. These levels can help teachers to reflect, understand, and evaluate how they are integrating ICT for teaching and student learning.

2.9 Levels of Teaching Innovation (Moersch, 2010)

Moersch (2010) first adapted the Concerns Based Adoption Model (Hall & Hord, 1987) in 1994 to introduce the Levels of Technology Implementation. With the emergence of the following: New Standards from the Partnership for 21st Century Skills (ACOT2, 2008); International Society for Technology in Education and National Educational Technology Standards and Performance Indicators for Teachers (International Society for Technology in Education [ISTE], 2000); and the No Child Left Behind Act (United States of America Department of Education (2002), the focus was changed from the Levels of Technology Implementation to Levels of Teaching Innovation.

The claim is the Levels of Teaching Innovation address unique attributes of the pedagogical continuum commencing from a teacher-centred approach to a more learner-centred approach. The levels highlight Bloom's taxonomy (Anderson & Krathwohl, 2001) in the changing levels of student cognition in the use of technology from knowledge and comprehension to higher levels of synthesis, evaluation, problem solving, and issues resolution. Of critical importance, the Levels of Teaching Innovation help to analyse a teacher's behaviour in the classroom. It shifts the emphasis from just the teacher's compliant use of digital tools and resources to a more dynamic involvement. This allows the teacher to self-reflect how they are using digital tools in the classroom. An examination of the eight stages or dimensions of the Levels of Teaching Innovation is enumerated in Table 3.

Table 3

Levels of Teaching Innovation (LoTi) (Moersch, 2010)

Levels	LoTi	Characteristics of each LoTi level
0	Non-Use	Instructional focus ranges from didactic to a collaborative, student-centred learning environment approach. There is an absence of technology integration.
1	Awareness	Application of digital tools and resources are used for lecture enhancement, curriculum management or as a reward for students’ completion of given task. Didactic approach and lower cognitive development skills are practiced.
2	Exploration	Students use digital tools for extension activities, research, and to produce multi-media products.
3	Infusion	Changes begin to emerge as teachers shift to a more inductive, scientific inquiry approach. This is accompanied by students using digital tools and resources for completing teacher-directed tasks which require higher levels of cognitive processing.
4 A	Integration Mechanical	Students engage in exploring real world issues and solve authentic problems using digital tools and resources. Teachers rely on pre-package materials and internal/external professional assistance from others. Applied learning and constructivist, problem-based models of pedagogical practices are adopted.
4B	Integration Routine	Teachers are within their comfort zones promoting inquiry-based models of teaching and learner-centred strategies. Students use digital tools and resources to investigate student-generated questions. Metacognitive skills, creativity and innovation, critical thinking and problem solving are more prominent in the learning environment.
5	Expansion	Teachers have progressed more efficiently with complex digital tools for transforming teaching and learning. Students’ application of digital tools and resources are more advanced at this level. They are proficient in collaborating with other diverse groups beyond the classroom to communicate and solve problems and resolve issues.
6	Refinement	There is no longer a division between instruction and digital tools and resources. Teachers are fully capable of integrating technology, content and pedagogy with emphasis on the students’ individual needs based on their interests and aspirations. Teachers and students are supported to ubiquitous access to the most current available digital applications and infrastructure.

The eight stages of Teaching Innovation reflect a number of theoretical domains including: the constructivist approach (Anderson & Krathwohl, 2001; Vygotsky, 1978), learning principles, such as Bloom's taxonomy (Anderson, 2006), problem-based learning, value beyond school, differentiated curriculum, authentic and relevant learning in real-time situation, digital resources and collaborative tools. These theories were previously discussed on pages 47 to 50.

Levels of Teaching Innovation set a benchmark of how teachers and students utilise digital tools for technology based digital curriculum activities. These levels also have the potential to provide understanding and insight into the evaluation of classroom based technology programs such as one-on-one instruction with technology, and the relevance of software and digital tools for a particular cohort of students. Furthermore, these levels could guide teachers of necessary adjustments required for the delivery of instruction and provide additional methods of reviewing where teachers have reached in terms of their technological pedagogical content knowledge. Therefore, the Levels of Teaching Innovation can be used as an informative as well as an evaluative tool for teachers' technological pedagogical content knowledge (TPACK). There is a defining relationship between Levels of Teaching Innovation and TPACK. This is outlined in Table 29 on page 201.

2.10 Research Questions

The core aim of this research is to investigate the Trinidad and Tobago eConnect and Learn program in alignment with the Trinidad and Tobago teachers' technological pedagogical content knowledge. Through interrogation of the literature numerous ways have been revealed to measure teachers' confidence to use ICT for technology enhanced (Anderson et al., 2013; Archambault & Crippen, 2009; Jamieson-Proctor et al., 2013; Mishra & Koehler, 2009; Schmidt et al., 2009).

In contrast, there was a paucity of similar research in Trinidad and Tobago. By 2014, four studies were conducted to investigate teachers' use of the eConnect and Learn program (Ali, 2013; Briggs, 2013; Onuoha, 2014; Sankar, 2014). These studies implemented either a qualitative or quantitative approach. A mixed methods approach has the tendency to produce a more robust study from different angles and perspectives (Tashakkori & Teddlie, 2003). Teaching experience, school category, qualifications, and instructional content areas are important variables to examine their impact on teachers' technological pedagogical content knowledge. Reviewing and interpreting teachers' pedagogical practices with ICT are essential for the future implications of the eConnect and Learn program.

Therefore, to supplement previous studies in Trinidad and Tobago, the three aims of the study on page 20 were used to craft eight research questions. The first five research questions were crafted from the first aim, "What factors influenced teachers' capacity to integrate ICT for their teaching and student learning? Research question six was crafted from the second aim, "What is the comparison of Trinidad and Tobago teachers' technology integration on an international level?" The final two research questions were crafted from the third aim, "What theoretical implications are there for the future of the eConnect and Learn program?"

Research Questions:

1: Based on teachers' survey results, what is the relationship between teachers' TK, TPK/TCK, and TPACK scores?

2: How confident are pre-service and in-service teachers to use ICT as determined by the TK, TPK/TCK and TPACK surveys?

3: Do teaching experience and school category impact upon teachers' TK, TPK/TCK, and TPACK scores respectively?

4: Do qualifications and instructional content areas impact upon teachers' TK, TPK/TCK, and TPACK scores respectively?

5: What are the factor structures of the teacher surveys?

6: What is the comparison of pre-service teachers' TPACK scores from Australia and Trinidad and Tobago?

7: Can Moersch's (2010) Levels of Teaching Innovation be used to review and interpret teachers' interview data relating to pedagogical practices with computers and related devices?

8: What implications are there for the future of the eConnect and Learn program in Trinidad and Tobago?

2.11 Summary of Chapter 2

The initial to the final phase of this literature review commenced with the investigation of an appropriate framework to construct the foundation of this study. Among four ICT models, the TPACK framework was selected. The literature review proceeded to examine studies related to the TPACK framework, One-to-One Computing, and the eConnect and Learn program. These findings initiated the crafting of the Learning Environment Model (LEM) with its contemporary theoretical underpinnings. The model has the potential to help teachers make more reflective and informed decisions relating to integrating ICT into their teaching and students' learning.

This review of the literature concludes by articulating that simply providing technology alone will not optimally harness development of skills for the 21st Century learning (Holcomb, 2009). Successful teacher and student usage of technology in the classroom will necessitate a deep understanding of how to efficiently locate, access, and utilised information effectively for communication, collaboration, and authentic learning.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The previous chapter explored current research related to teachers' confidence in the integration of ICT with their pedagogical practices for the delivery of instructions in a global context. Special emphasis was given to the eConnect and Learn program which was initiated in Trinidad and Tobago since 2010. Each student was provided with a free personalised HP or Lenovo laptop computer. A review of the literature relating to computer technology integration lead to the examination of several ICT frameworks; teaching and learning theories; and 21st Century pedagogical skills. Analyses of these paradigms lead to the construction of a Learning Environment Model (LEM) to attempt to better conceptualise how the eConnect and Learn program can be implemented.

This chapter presents the methodological approaches adopted for the research investigation for the study. Six sections facilitate a description of each part of the research process. Section one explores the *research approach* with a brief description of the rationale for the eight research questions. Section two explores three *research designs* and argues for the most appropriate methodological design for the study. Section three captures the *developmental phase* which describes the development of the research process, including ethical clearance, participants' informed consent, confidentiality involved in the study, and assurance to protect participants from harm. In addition, this section also gives an overview of the attributes of the educational institutions and participants in the study. The fourth section introduces the *TK and the TPACK survey instruments*. Section five is *procedur*e which examines the *methods of* *data collection* through a two phase process: survey instruments and semi-structured interviews, and introduces the forms of data collection. Section six is the *data analysis procedure* which summarises the mixed methods approach used to analyse the data quantitatively and qualitatively. Emphasis is given to ensure the data file was screened before any analysis was conducted. The conversion of a 7 point scale to a 6 point Likert scale was also completed to facilitate Research Question 6. Finally the chapter concludes with a general summary.

3.2 Research Approach

"Research methods should follow research questions in a way that offer the best chance to obtain useful answers," (Johnson & Onwuegbuzie, 2004, pp. 16-17). After several attempts of construction and reconstruction, eight research questions were eventually finalised. Four constructs of the TPACK framework: technological knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK), were important for formulating six of the research questions in this study. The other three constructs of the TPACK framework, content knowledge (CK), pedagogical knowledge (PK), and pedagogical content knowledge (PCK) were not utilised in isolation in the study but were embedded in the four dimensions: TK, TPK, TCK, and TPACK.

Two survey instruments were essential for this study. One was the TK survey which investigated teachers' confidence to use 12 technological devices for their pedagogical practices. The other was the TPACK survey which measures teachers' confidence to use ICT on the TCK, TPK, and TPACK scale. Research Question 1 was designed to determine the correlations of the variables in these two surveys. Research Question 2 was constructed because pedagogy in the current learning environment is quite different from the past two decades. Teachers require confidence, knowledge and skills, to select and use appropriate technologies for supporting students in accessing information to construct new knowledge and skills for the 21st Century (Finger et al., 2007; Lloyd, 2013). In this regard, Research Question 2 sought to investigate teachers' confidence to use ICT for teaching and student learning as determined by the surveys. Because there was such a close relationship between the TPK and TCK items on the survey, it was difficult to differentiate them (Jaikaran-Doe & Doe, 2016). TPK and TCK items were placed on the same dimension of the survey; therefore the term TPK/TCK for this dimension will be used throughout this study. Teachers' ability to transform learning in more innovative and creative ways can be impacted upon by their pedagogical practices, the learning environment, mastery of instructional content areas, and level of qualifications.

Research Question 3 explored the impact of *teaching experience* and *school category* on TK, TPK/TCK, and TPACK, whereas, Research Question 4 explored *qualifications* and *instructiona*l *content areas* on TK, TPK/TCK, and TPACK. According to Jamieson-Proctor et al. (2013b, p. 30), it was also important to investigate "statistically credible and theoretically intelligible factors" in survey instruments. Research Question 5 which explored the factor structure present in both surveys was positioned after Research Questions 2, 3 and 4 in order to allow the reader to become familiar with the items of the surveys.

It was important to position Trinidad and Tobago teachers' use of ICT to support their students' use of ICT, not only on a national level but also from an international perspective. This has the potential to provide a broader and deeper understanding of teachers' TPACK confidence. Therefore Z scores were calculated to compare Trinidad and Tobago and Australian teachers' TPACK in Research Question 6.

Research Question 7 was designed to explore whether Moersch (2010) Levels of Teaching Innovation can be used to review and interpret teachers' interview data relating to pedagogical practices with computers and related devices. In Research Question 8 in order to capture further insights of the study, teachers, school supervisors, ICT technicians, and the Director of the eConnect and Learn program were invited to voice their opinions, perceptions, and discuss the implications of the eConnect and Learn program (Foor, Walden, & Trytten, 2007; Yin, 2003).

3.3 Exploring Three Research Designs

The epistemological foundation for the selection of methodologies for data collection and analyses of the eight research questions provided the opportunity to explore an array of research approaches. In the quest for the most appropriate research method, the following quality criteria were sought: transparency to produce rigorous analytical results; robustness in terms of validity and reliability of its design; and a method congruent with the research questions (Bryman, Becker, & Sempik, 2008) but culturally acceptable to the target population. Three genres of research approaches were explored to facilitate these criteria for the current study: qualitative, quantitative, and mixed methods. The characteristics of these methods will be described first followed by the rationale for the selection of the most appropriate research design for this study.

3.3.1 Qualitative research design.

Qualitative research is rigorous and has advanced significantly to a carefully planned research design. It involves all aspects of the study, commencing from the research questions to sampling to data collection and moving to the analysis, utilising procedures and techniques which ensure the trustworthiness of the findings (Frankel &

Devers, 2000). This method is characterised by the collection and analyses of textual data such as surveys, interviews, focus groups, conversational analysis, questionnaires and ethnographies (Olds, Moskal, & Miller, 2005) and focuses on the context within which the study occurs. Qualitative designs answer ‘how’, ‘what’ and ‘why’ questions especially when the researcher has little control over the events (Yin, 2003), thus generalizing through thick descriptions of the context, allowing the reader to make connections between the study and his or her own situation. Given qualitative work is considered to be more inherently interpretive research, the biases, values, and judgments of the researchers need to be more explicitly acknowledged so they are taken into account in data presentation (Creswell, 2009).

The debate on qualitative analysis is not to provide a broad, generalizable description which is representative of most situations, but rather to describe a particular situation in enough depth that the full meaning of what occurs is made apparent. Another perspective described by Foor et al. (2007) examined qualitative analysis through the lens of statistical analyses which can bury the voices of underrepresented groups through surveys and questionnaires and which do not describe marginalized individual’s experiences. Giving voice to the “other” is a key component in qualitative research which allows the respondents to discuss the topic in their own words, free of constraints from fixed-response questions found in quantitative studies.

On the other hand, Crotty (2003) explained qualitative research as reality; it is related to a particular epistemology, or way of understanding reality. Thus it is evident there are many epistemological findings pertaining to qualitative analysis. The researcher has to sift through all the debates relating to qualitative research and select the most appropriate approach which matches his/her research questions.

3.3.2 Quantitative research design.

Quantitative research design is quite different from the qualitative paradigm. Quantitative design is a good fit for deductive approaches, in which a theory or hypothesis justifies the variables, the purpose statement, and the direction of the research questions. A hypothesis is typically formulated as a research question, and then data are collected such as from a locally developed and validated survey or commercial instruments, frequently using experimental designs. Rigorous statistical analysis is essential in quantitative research to ensure reliability and generalizability. Also different statistical analyses are used to examine the data (Creswell, 2002).

Descriptive statistics such as percentages, means and standard deviations are utilized for illustrating various points and for describing a situation, particularly one that has not been studied previously (Hodge & Steele, 2002; Todd, Magleby, Sorensen, Swan, & Anthony, 1995). Significant differences between groups on various indicators (variables), for example, cause and effect can be examined (Carpenter, Harding, Finelli, Montgomery, & Passow, 2006). The researcher has the opportunity to generalize and/or make inferences. Additionally, the results are interpreted to determine the probability that the conclusions will be replicated within the larger population through an objective process.

3.3.3 Mixed methods research design.

Mixed methods research design is gaining popularity exponentially and has been described as the third methodological movement following quantitative and qualitative oriented approaches (Tashakkori & Teddlie, 2003). Scholars highlighted that strategies can be used for linking qualitative and quantitative methods in a complementary fashion (Miles & Huberman, 1984; Patton, 2002; Sandelowski, 2000). Collection, analysis, and integration of quantitative and qualitative data are possible in a single or multiphase study.

Integration of the results from a dataset provides a better understanding and a broader picture of the problem than if either set of quantitative or qualitative data was used separately. According to Creswell and Clark (2007, p. 7) there are three possible ways of integrating the dataset:

> Merging or converging the two datasets by actually bringing them together; connecting the two datasets by having one build on the other; or embedding one dataset within the other so that one type of dataset provides a supportive role for the other dataset.

The advantage of mixed methods research provides strength to offset the weaknesses of quantitative and qualitative approaches. The line of argument claims quantitative approach is weak in understanding the full context of the study (Jick, 1979). Participants' verbal viewpoints, biases, and interpretations are excluded from the study. Also a qualitative approach by itself could be inadequate because the interpretations and viewpoints of participants can influence generalization which may be formulated from the biases of information given.

3.4 Selection of an Appropriate Research Design

Mixed methods research design was given priority in this study. Quantitative data were collected in phase one of the study from the TK and TPACK surveys. The quantitative data informed the qualitative phase of the research and facilitated the crafting of the questions for the interview sessions. The in-depth and contextualised insights associated with the interview were used to better understand, explain, and build on the results from the predictive power of the quantitative approach (Creswell & Clark, 2007). This was particularly true for this research, whereby the qualitative data were used to enhance the quantitative findings and enable more detailed information to be gained enabling the eight research questions to be tackled from different perspectives. In particular, the quantitative findings from the analysis of Research Questions 1 to 6 and the qualitative results from Research Questions 7 and 8 had the potential to be combined and/or integrated (Creswell, 2009) during the discussion in Chapter Five of this study.

This approach to inquiry associated both methods which were connected and integrated to produce a broader and better understanding of the study (Bryman, 2006; Creswell, 2008; Tashakkori & Teddlie, 2003). The association also provided a complete transparent picture for the results which could not be generated by any one method alone. For this reason mixed methods research design offered the best of both worlds (DeCuir-Gunby, 2008). Mixed methods research is a robust, versatile, multifaceted approach for the current study.

3.5 Developmental Phase of the Study

This section presents the developmental phase of the study. It focuses on ethics applications from two different sources, the process involve in acquiring participants consent to take part in the study, and maintenance of confidentiality. An overview of school category and attributes of participants is also provided.

3.5.1 Ethics Applications.

Ethics approval to conduct the study was sought from two different organisations. The first was a minimum risk application from the Faculty of Education Ethics Board and the Human Research Ethics Committee within the University of

Tasmania. Approval with the Reference Number H0013354 was granted in June, 2013. The second was sought from the Educational Planning Division of the Ministry of Education in Trinidad and Tobago. Approval was granted on September, 2013. As plans for the study progressed, insights of each step became clearer, broader and deeper. To fully perceive how teachers were infusing the eConnect and Learn program, it became clear that school supervisors, ICT technicians, and the Director of the program should also be included in the study. Simultaneously, it was also important to investigate how pre-service teachers were being prepared to integrate the eConnect and Learn program for their future teaching and students' learning. Therefore two amendments were made to the first ethics application to the University of Tasmania Ethics committee. These were granted on September, 2013 and October, 2013 while the researcher was engaged in field work. (See Appendix A).

3.5.2 Participants consent: Information letters and consent forms.

Following approval from the two organisations, emails were sent to Principals of 14 secondary schools as well as the Principals of the two campuses which provide teacher education in Trinidad and Tobago to make initial contact, and to briefly provide the aims of the study. (See Appendix B). After arriving in Trinidad and Tobago in September, 2013, the researcher visited each institution and arranged a time and date to meet with the Principal to explain details of the study. During the scheduled meeting with each Principal information sheets and consent forms were explained and presented. All information sheets detailed the purpose of the study, the interview process, the assurance of confidentiality, and further information about the benefits of the study. The Principals from 12 secondary schools agreed to inform members of staff about the study and to distribute the information sheets and the consent forms. Two schools declined the invitation. Principals of the two campuses of the University of Trinidad and Tobago also gave permission for students (pre-service teachers) to participate in the study. A time limit of five days was agreed upon for teachers who consented to participate in the study to return the consent forms to their Principals. Phone calls were made to confirm whether the consent forms were signed and were ready for collection.

On receiving the signed consent forms from each Principal, a corresponding number of sealed envelopes with the survey instruments were submitted to the Principal for distribution to teachers who gave their informed consent to participate in the study. A timeframe of two weeks was agreed for the completion of the surveys. It was agreed for these to be returned to the Principals. Prior to collection from Principals, phone calls were made to ensure the completed survey instruments were ready for collection. Each returned copy was given an alpha-numeric code, for example, “ISCG 3”, which was known only to the researcher. Teachers were invited to participate in follow-up interviews by signing the consent form attached at the end of the survey instrument. Those who agreed to participate were asked to write either their email address or their telephone number. This was necessary to make further arrangements for the interview. Each interview was audiotaped. Each transcript was also given an alpha-numeric code. The transcript was emailed to each interviewee for member checking to add, extract, or modify any necessary information. Responses were returned by email to the researcher. A similar procedure was established for school supervisors, the Director of the eConnect and Learn program, and ICT technicians who participated in the interview. (See Appendix C).

3.5.3 Confidentially of participants.

The survey was not completed online because of inadequate accessibility to internet connectivity in the schools and homes in Trinidad and Tobago. Completed surveys were collected from the Principals and were given an alpha-numeric code for future identification. Data from the participants who did not wish to participate in the interview were identified by code and stored securely for analysis. Interview recordings were transcribed and de-identified. An alpha-numeric code was assigned individual responses from the interview and were quoted in presenting the findings of the study in Chapter 4.

The survey data were stored electronically at the University of Tasmania's cloud data storage. All survey data were also kept in electronic files via a password-protected computer as a 'back-up' and was de-identified. Digital audio recordings and transcripts were kept in electronic files accessed via a password-protected computer. All electronic files were de-identified. At the end of five years, all files (electronic) which were stored in the University of Tasmania cloud data storage will be deleted with my permission or my supervisors' permission. Electronic files will also be deleted from the password-protected computer hard-drives, and electronic "rubbish bins" will be emptied during that same period.

3.6 School Type

The researcher's experience of working as a secondary school teacher in Trinidad and Tobago from 1975 to 1999 informed the purposeful selection of educational institutions for the study. Two categories were selected. The first included the two campuses which provided teacher education at the University of Trinidad and Tobago and the second included 14 secondary schools. Candidates at the universities are referred to as *pre-service* teachers whereas teachers employed at secondary schools are referred to as *in-service* teachers in this study. School type included government or denominational schools. Enrolment of students (11 to 18 years of age) at these institutions consisted of either male or female students only, or a combination of both male and female students (co-educational). Secondary schools offered either a five-year curriculum or a seven-year curriculum. Location included rural, semi-rural, urban, and semi-urban. Schools selected were representative of all the secondary schools in the country. The selection of the two categories (University and secondary schools) were important variables to make comparison between pre-service and in-service teachers' confidence to integrate ICT in their teaching and student learning. In addition, the selection of pre-service teachers enabled comparison of technological pedagogical content knowledge scores on a national and international platform. Attributes of school type, years for curriculum offered, and the location of the 12 secondary schools selected from four of the eight educational districts of Trinidad and Tobago are presented in Table 4.

Table 4.

Overview of School type

Educational district	Schools	School type		Location	Curriculum
Victoria	School 1	Single Gender	Denominational	Urban	7 years
	School 2	Single Gender	Denominational	Semi-rural	7 years
	School 3	Single Gender	Denominational	Semi-rural	5 years
	School 4	Coeducational	Government	Rural	5 years
	School 5	Coeducational	Government	Semi-urban	5 years
South Eastern	School 6	Coeducational	Denominational	Urban	7 years
	School 7	Coeducational	Government	Rural	7 years
	School 8	Coeducational	Government	Semi-rural	7 years
	School 9	Coeducational	Government	Rural	5 years
Caroni	School 10	Single gender	Denominational	Urban	7 years
	School 11	Coeducational	Government	Semi-urban	5 years
Tobago	School 12	Coeducational	Government	Semi-urban	7 years

3.7 Attributes of Participants

Among a total of 567 teachers from the 12 secondary schools, 173 in-service teachers gave their informed consent to participate in the survey. This provided a response rate of 31%. Among the pre-service teachers from the universities, 53 of them gave their informed consent to participate in the survey. Unfortunately, information related to the total number of final year students at the two campuses of the universities was unavailable at the time of the study; some students attended both campuses.

The participant pool which accepted the invitation to participate in the semi-structured interview sessions, comprised 15 pre-service teachers, 21 in-service teachers, three school supervisors, five ICT technicians, and the Director of the eConnect and Learn program. The demographic data provided information which contributed to the attributes of the participants.

3.7.1 Pre-service teachers.

Pre-service teachers were in their final year studying for an undergraduate degree and were preparing to commence their initial teaching career in September, 2014. Three years of coursework had already been completed in areas such as Foundations of Education, Psychology of Learning and Human Development, Educational Technology, as well as specialisation in an instructional content area (English, Maths, Science, or social studies). Pre-service teachers had already completed two months out of three months (320 hours) of teaching practicum (learning experience) in various secondary schools. This cohort formed a convenient sample that was representative of pre-service teachers in Trinidad and Tobago.

3.7.2 In-service teachers.

In-service teachers from the 12 secondary schools had varying career stages. They were employed with an undergraduate degree with or without teacher education certification. This is the norm in Trinidad and Tobago since the education system lacks legislation to ensure all teachers are adequately certified with teacher education to be employed in schools. In some cases, teachers were also qualified with a Master degree.

Teaching experience for in-service teachers ranged from one year to more than 15 years in either government or denominational secondary schools. In-service teachers were responsible to deliver instructions in one or two subject areas for each class, which contained approximately 20 to 25 students. The cohort of in-service teachers formed a convenient sample which was representative of in-service teachers in Trinidad and Tobago.

3.7.3 School supervisors.

Three school supervisors participated in this study. Formerly they were Principals in either secondary or primary schools. Prior to this they were classroom teachers with over 20 years of teaching experience. At the time of the study they were currently responsible for organising professional development for Principals and teachers through program proposals, training seminars, and workshops. In addition, they were responsible for supervisory and administrative jobs, and were accountable for monitoring and evaluating the implementation of the eConnect and Learn policies and procedures in their school district (MOE, 2010a). Their portfolio also included organising teacher professional development in the use of ICT in teaching and learning. Together with all of this, they monitored ICT integration lessons during workshops. This cohort formed a convenient sample representative of school supervisors in the eight educational districts.

3.7.4 ICT technicians.

One ICT technician was employed in each secondary school with an average population of 650 students. Each technician had several roles, such as responsibility to oversee the smooth implementation of the eConnect and Learn program in his/her school; to ensure there is proper communication with the Information Technology department in terms of the laptops and desktop computers in the school; to maintain the WiFi system; and to repair broken laptop computers after the one-year warranty expired. In addition to this, each ICT technician was also assigned to at least five primary schools where he/she was responsible for technical matters concerning computers in the schools' laboratories. Students at the primary level were not provided with free personalised laptop computers. This cohort of ICT technicians formed a convenient sample representative of all ICT technicians in the eight educational districts.

3.7.5 Director of the eConnect and Learn program.

One Director was appointed to oversee the entire eConnect and Learn program in the country. He supervised the project managers, systems specialists, systems analysts, programmers, and ICT technicians. His portfolio required him to communicate directly with the Minister of Education on matters relating to the eConnect and Learn program.

3.8 Survey Instruments

This section presents the survey instruments for the study. Firstly, a total of eight survey instruments on the technological pedagogical content knowledge (TPACK) framework were examined to select the most appropriate one for this study. Three of them were selected for further investigation (Graham et al., 2009; Jamieson-Proctor et al., 2013b; Schmidt et al., 2009). The final selection was based on the design of items which required simplicity and clarity for easy comprehension by in-service and pre-service teachers. In addition, the instruments needed good reliability. Reliability of an instrument means how "free it is from errors" (Pallant, 2013, p. 6). This can be achieved by assessing the internal consistency. In this study internal consistency refers to the degree to which all the items measure the same underlying attributes related to the surveys. Internal consistency is measured using Cronbach's coefficient alpha (α) with values > .9 = Excellent, .8 = Good, .7 = Acceptable, .6 = Questionable, .5 = Poor, < .5 = Unacceptable (George & Mallery, 2003).

The first instrument by Schmidt et al. (2009) was developed and validated to measure the seven constructs of the TPACK framework. Although the survey was robust with factor loadings of over .60 and was very reliable with a high internal consistency of α >.8 for each of its constructs, the survey was designed for pre-service teachers designated to teach kindergarten to Grade 6. As a result, this survey was not appropriate for in-service and pre-service teachers who were responsible for delivering instruction to students from Grade 7 to Grade 10/12 in secondary schools.

The second instrument which was examined, consisted of 31 items on a survey instrument associated with the areas of technological knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK) and technological pedagogical content knowledge(TPACK) (Graham et al., 2009). The stem of the question asked teachers to "Rate how confident you are in your current ability to complete each of the following tasks." Teachers (N = 15) responded on a Likert scale from 1 to 6 with 1 = not confident at all and 6 = completely confident. Although this instrument had an acceptable reliability, ranging from α = .92 to α = .95 for the four constructs, it was unsuitable for this study because it was specifically designed for elementary school teachers in the science discipline. In addition, there were few participants.

An examination of a third instrument was the TTF TPACK survey (Jamieson-Proctor et al., 2013b). This survey was developed and statistically validated as a result of the national Teaching Teachers for the Future (TTF) project in Australia in 2011 (Jamieson-Proctor et al., 2013). Development of the survey was informed by previous work on the measurement of TPACK and ICT integration in classrooms (Albion, Jamieson-Proctor, & Finger, 2010; Jamieson-Proctor & Finger, 2008; Jamieson-Proctor et al., 2007). The three constructs of the survey had strong internal consistency: α (TPK) = .97; α (TCK) = .98; α (TPACK) = .98.

The TTF TPACK survey was designed for pre-service teachers. It consisted of two dimensions. The first dimension comprised items related to TPK and TCK. The second dimension comprised items related to TPACK. Both dimensions comprised a confidence scale and a usefulness scale, each of 24 survey items (questions). The TPK and TCK dimension explored the confidence of teachers to use ICT to support their teaching; the TPACK dimension explored the confidence of teachers to support their students' use of ICT to enhance student learning. Participants were required to respond to each item on a 7-point Likert scale ranging from 0, not confident to 7, most confident. An examination of the design of the items revealed the survey was applicable to in-service teachers as well as pre-service teachers. Therefore, this survey was appropriate and was accepted as one of the surveys for this study. What was interesting about the TTF TPACK survey was its alignment of each item with the National Professional Standards for Teachers (Australian Institute for Teaching and School Leadership [AITSL], 2011). Examples of this alignment with the TPK and TCK items were provided in Table 5. The number in parenthesis at the end of each row indicated the location of the descriptor in the National Professional Standards for Teachers.

Table 5

Some TPK/TCK items aligned with the Australian National Standards for Teachers

TPK/TCK items	National Professional Standards for Teachers (Descriptor)
Demonstrate knowledge of a range of ICT to engage students.	Demonstrate knowledge of a range of resources, including ICT that engage students in their learning (3.4).
Use ICT and teaching strategies that are responsive to students' diverse backgrounds.	Demonstrate the ability to match digital resources and tools with teaching strategies in ways that are responsive to students' diverse backgrounds. (1.3).
Use ICT and teaching strategies that are responsive to students' learning styles.	Select and use specific digital resources and tools that are matched to teaching strategies designed to meet students' individual and diverse learning needs (1.5).
Use ICT to teach your specific subject/s in creative ways.	Demonstrate knowledge and understanding of how to support teaching strategies through the use of digital resources and tools in ways that facilitate accelerated and deep learning, promote creative and innovative thinking and inventiveness (3.3).
Demonstrate knowledge of a range of ICT to engage students.	Demonstrate knowledge of a range of resources, including ICT, that engage students in their learning (3.4).
Use ICT and teaching strategies that are responsive to students' diverse backgrounds.	Demonstrate the ability to match digital resources and tools with teaching strategies in ways that are responsive to students' diverse backgrounds (1.3).
Use ICT and teaching strategies that are responsive to students' learning styles.	Select and use specific digital resources and tools that are matched to teaching strategies designed to meet students' individual and diverse learning needs (1.5).
Design lesson plans and assessments that incorporate ICT use by students.	Demonstrate the ability to use digital resources and tools when devising learning sequences and lesson plans designed to meet curriculum, assessment and reporting requirements (2.3).

Note. The Teaching Teachers for the Future (TTF) project is funded by the Australian Government Department of Education, Employment and Workplace Relations (DEEWR) through the ICT Innovation fund. The numbers in parenthesis indicate the focus area of AITSL (2011).

3.8.1 Adaptation of the TPACK survey for Trinidad and Tobago teachers.

The TTF TPACK survey will be referred to as the TPACK survey to facilitate Trinidad and Tobago teachers. Only the confidence scale, rather than the usefulness scale, of the TTF TPACK survey was employed for this study because Trinidad and Tobago teachers could more effectively self-assess their confidence in using ICT to support teaching and student learning. The TPK and TCK items on the confidence scale was labelled TPK/TCK for easy identification of its dimension for the purpose of this study.

The TPACK survey was tested for the suitability of items for teachers in Trinidad and Tobago. According to (Czaja & Blair, 2005, p. 73), "the reliability of data obtained through survey research rests, in large part, on the uniform administration of questions and their uniform interpretation by respondents." Four colleagues with over 12 years of teaching experience from Trinidad and Tobago were invited to complete the surveys to determine the suitability and the structure of items. They were asked to pay particular attention to whether the items were easy to understand and if clear meaning was generated for each item when read. (These teachers did not participate in the final adapted survey instruments). Based on their recommendations, adaptations were made to the following items which were italicised in Table 6 for easy recognition.

Table 6

Adaptations to items in the TPACK Survey

Original items from the TPACK survey	Reworded items for Trinidad and Tobago context
TPK/TCK items	**TPK/TCK items**
Use ICT and teaching strategies to support students from *Aboriginal and Torres Strait Islander backgrounds*.	Use ICT and teaching strategies to support students from *disadvantaged backgrounds.*
Use ICT and teaching strategies to *personalize* learning activities for students.	Use ICT and teaching strategies to *plan individualized* learning activities for students.
Use ICT to access, record, manage, and analyse student *assessment* data.	Use ICT to access, record, manage, and analyse student *record* data.
Use ICT to teach specific subject *areas* in creative ways.	Use ICT to teach *your* specific subject *area/s* in creative ways.
Design *learning sequences,* lesson plans and assessments that incorporate ICT use by students.	Design *lesson plans* and assessments that incorporate ICT use by students.
TPACK items	**TPACK items**
Develop functional competencies in a specified *curriculum area*.	Develop competencies in *your subject area/s*.
To integrate different media to create appropriate *products*.	To integrate different media to create appropriate *projects*.
To develop *deep* understanding about a topic of interest relevant to the curriculum area/s being studied.	To develop *rich* understanding about a topic of interest relevant to the curriculum area/s being studied.
Support elements of the learning process.	*Engage in activities* of the learning process.

Because changes were made to some of the items of the survey it was germane to explore the correlation of the variables and the reliability of the adapted TPK/TCK and TPACK dimensions. It was also necessary to determine if this impacted on the internal consistencies. These were fully explored by Research Questions 1 and 5 in Chapter 4.

3.8.2 Selection of an appropriate TK Survey.

The TPACK survey did not include a TK construct. Therefore three instruments were examined (Albion et al., 2010; Schmidt et al., 2009; Williams et al., 2000) for the selection of the most appropriate TK survey for participants in this study. Although the first instrument by Schmidt et al. (2009) was well designed with seven questions related to TK, they were too generic. For example, one question asked, “I keep up with new technologies,” and another asked, “I know a lot about different technologies.” This instrument was inappropriate because the author of this study wanted to know how confident teachers were to use specific technological devices for their teaching and eLearning. The second TK instrument was constructed by Albion et al. (2010) for teachers who were well knowledgeable of the use of technological devices. The 19 items of the survey ranged on a continuum of very simple to very complex. Since the eConnect and Learn program started in 2010, it was unlikely teachers in Trinidad and Tobago would have acquired the technological knowledge and skills to use the more complex devices such as, Visual Thinking Software (e.g. Inspiration, Kidspiration, CMap) and online learning management systems (e.g. Blackboard). A more appropriate TK survey instrument with potential to be adaptable for participants in this study was informed by Williams et al. (2000). Permission was sought and granted to use the TK section of the survey instrument (D. Williams, personal communication, April 4th, 2013).

3.8.3 Description of the TK survey.

The following eight items out of 15 from the TK survey instrument by Williams et al. (2000) were retained for this study because of their appropriateness for teachers in Trinidad and Tobago: World Wide Web, word-processing, databases, spread sheets, digital camera, external and internal software. Added to the list of items by the researcher of this study were: computer, multi-media devices, digital video for production and editing, interactive whiteboard, and webpage design. Because changes were made to the survey, it was important to investigate the reliability of the instrument; the factor structure; and the correlation of TK with TPK/TCK and TPACK. These were fully computed and reported by Research Questions 1 and 5 in Chapter 4. The scree plots for the factor structures of TK, TPK/TCK and TPACK were detailed in Appendix H.

3.9 Demographic Data Sheet and Open Ended Questions

A demographic data sheet was attached at the beginning of the survey instrument for teachers to indicate their gender, instructional area/s, teaching experience, classes taught, and academic qualifications including ICT training. Four additional open-ended questions asked teachers to describe the challenges and or successful outcomes that they and their students encountered in making ICT integral to teaching and learning. It was anticipated the response would provide the researcher with a better understanding of how the affordances of the eConnect and Learn program were used by a larger group of teachers. Also the responses were used as a guide to formulate questions for the semi-structured interviews.

3.10 Data Collection from Surveys

Data were collected from October 2nd, 2013 to January 31st, 2014 in two phases. The first phase was the collection of quantitative data from pre-service and in-service teachers who completed the TPACK and TK surveys. Responses to the items on the survey were coded in the data files in IBM Statistical Package for the Social

Sciences (SPSS) Version 21. Before the data file was created in IBM SPSS, a codebook was prepared to define and label each variable in the study as well as to assign numeric codes to each of the responses from the demographic sheet and survey instruments. After the data were entered in SPSS, the data were screened and cleaned for errors on the categorical variables: (identification number for each in-service and pre-service teacher, gender, teaching experience, subject, qualifications, school type, and service) and continuous variables (TPK/TCK, TPACK, TK). Frequency tables and descriptive statistics were generated using IBM SPSS Statistics Version 21 to check for errors that fell outside the range of possible values for the categorical and continuous variables respectively.

Inspecting the minimum and maximum values on the generated outputs for the frequency table indicated there was one error for the gender variable whereas there were three errors for the TPK/TCK variables. Correction of these errors involved identifying the errors in the Data View and locating the ID case for each. The miss-entered value for gender was changed from 31 to 1, which was the code for male. The survey package corresponding to the three ID cases with the errors on the continuous variables were retrieved and examined for the appropriate response on the Likert scale for item Q1.10, Q1.21, and Q2.5. The errors were removed from the Data View and replaced with the accurate responses from the survey instruments. Once the data file was cleaned, subscales for the continuous variables, TK, TPK/TCK, and TPACK, were set up to conduct future relevant tests with SPSS.

3.11 Data Collection from Semi-structured Interviews

It is suggested interviews are one of the most powerful ways which researchers can gather data through communication. This is an important approach used by qualitative researchers to explore issues and ideas which are revealed through the lived experience of participants (Lichtman, 2006; Patton, 2002). The semi-structured interviews in this study were conducted for pre-service teachers, in-service teachers, school supervisors, ICT technicians, and the Director to share their experiences and perceptions of the eConnect and Learn program. Each interview was conducted in a quiet room at the participant's workplace. The sessions were face to face and on a one-to-one basis. At the commencement, participants were reminded their participation was voluntary, their responses would remain confidential, and they had the opportunity to decline to respond to a question or they could withdraw at any time.

Responses to the open-ended questions from the demographic sheet and the survey instruments had guided the structuring of questions for the interview session. Questions for each cohort were based on their experiences with the eConnect and Learn program. Consideration was given to variations in techniques of discussions as participants responded differently to the questions. This method was important to give teachers the opportunity to expand and provide different levels of detail associated with the different questions, such that ideas were discussed in depth and in greater length when and where necessary.

Illustration of commencing the questioning technique is briefly discussed in relation to Kahneman and Frederick (2005, p. 271) who articulated, "The question of why thoughts become accessible and why particular ideas come to mind at particular times has a long history in psychology and encompasses notions of stimulus salience, associative activation, selective attention, specific training, and priming." Utilizing this premise, the interview session began by asking in-service and pre-service teachers, "What comes to your mind when you hear the acronym ICT?" The opening question stimulated teachers to think about ICT tools, make association with their ICT training and experiences in the application of ICT for pedagogical practices. This thought process was supported by (Vygotsky, 1987, pp. 236-237) who stated, "every word people use in telling their stories is a microcosm of their consciousness." The second question deduced teachers' understanding of TPACK. This was followed by questions directly related to the eConnect and Learn program, such as: provision for support; seminars, workshops or conferences attended; pedagogical practices; methods adopted for ICT integration; collaboration among peers; reflections, concerns, and implications for the eConnect and Learn program. The interview sessions for the school supervisors, ICT technicians, and the Director of the program were guided by information analysed from a number of online policy documents of the eConnect and Learn program.

The semi-structured nature of the interviews enabled discussions to be stimulated and particular points of interest to be clarified by the participants and the researcher. These responses were important for the analysis of Research Questions 7 and 8. Research Question 7 investigated whether Moersch's (2010) Levels of Teaching Innovation can be used to review and interpret teachers' interview data relating to pedagogical practices with computers and related devices. Research Question 8 focused on implications for the future of the eConnect and Learn program. The responses to these research questions helped to clarify and better understand the quantitative results obtained for Research Questions 2, 3, 4 and 6. See Appendix E for sample questions.

Interviews were recorded on a Sony ICD-P620 digital recorder. An iPhone 3 was used as a back-up. After each interview was recorded, it was transferred to the Listen N Write software (http://download.cnet.com/Listen-N-Write/3000-2170_4-75416316.html) which was installed on the researcher's personal computer. This software had a pause, review, and slow playback control that facilitated transcription.

The researcher was familiar with the Trinidadian dialect and was therefore able to gain a clear understanding of participants' responses.

After transcribing each interview it was emailed to the interviewee for member checking to confirm that the transcribed content was exactly what he/she wanted to say. As soon as the participants' feedback was received, the necessary changes were made to the original transcript which was already uploaded on the researcher's computer (See Appendix F for a sample of a transcript). After reading each transcript at least two times for familiarity (Miles & Huberman, 1984), it was imported into NVIVO 10 software for Window which was installed on the researcher's computer. NVIVO is a versatile integrative software that provides tools to support the analysis of data by making use of strategies concurrently such as reading, coding, annotating, memoing, discussing, linking, modelling and visualizing (Bazeley & Jackson, 2013)

3.12 Quantitative Data Analysis Procedure

This section describes the procedures for data analysis in order to answer six of the research questions based on the collection of quantitative data from the surveys. Because a mixed methods research design was utilised for this study, the procedure used for quantitative analysis will be discussed first followed by the qualitative procedure. Preliminary tests on data collected were conducted to ensure there were no violations of assumptions, such as normality, outliers, linearity, internal consistency, and homogeneity of variance (Pallant, 2013; Tabachnick & Fidell, 2013) for the continuous variables: TPK/TCK, TPACK and TK. Violations of these assumptions can produce inaccurate results.

3.12.1 Normality.

Normality is important to show if the data points were normally distributed. An inspection of the output generated by SPSS, revealed there were no violations of assumptions. The distribution of scores was normally distributed for TK and TPACK variables because a non-significant result (significant value > .05) was obtained for Kolmogorov-Smirnov and Shapiro-Wilk except for TPK/TCK. This was not a problem because there were more than 100 cases. The results are presented in Table 7.

Table 7

Tests for Normality

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
TK	.047	220	.200[a]	.989	220	.087
TPK/TCK	.061	226	.041	.988	226	.061
TPACK	.058	222	.066	.990	222	.117

[a]Lower bound of the true significance.

The histograms generated by IBM SPSS for the dependant variables, TK, TPK/TCK and TPACK reported normally distributed scores for each. This is illustrated in Figure 7, Figure 8 and Figure 9. Their descriptive statistics is displayed in Appendix G.

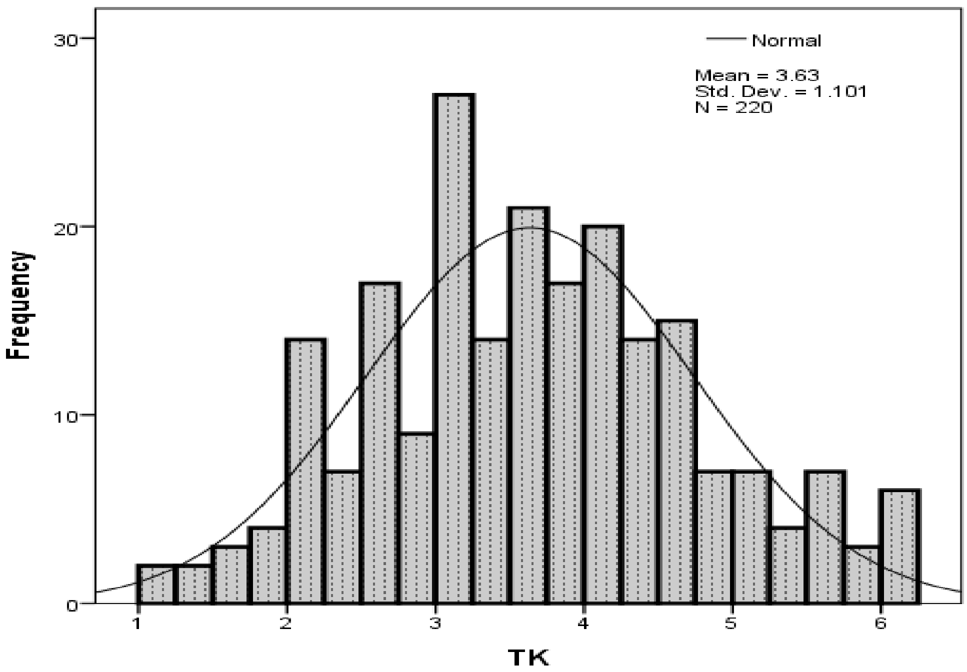


Figure 7. Distribution of scores on the TK variable.

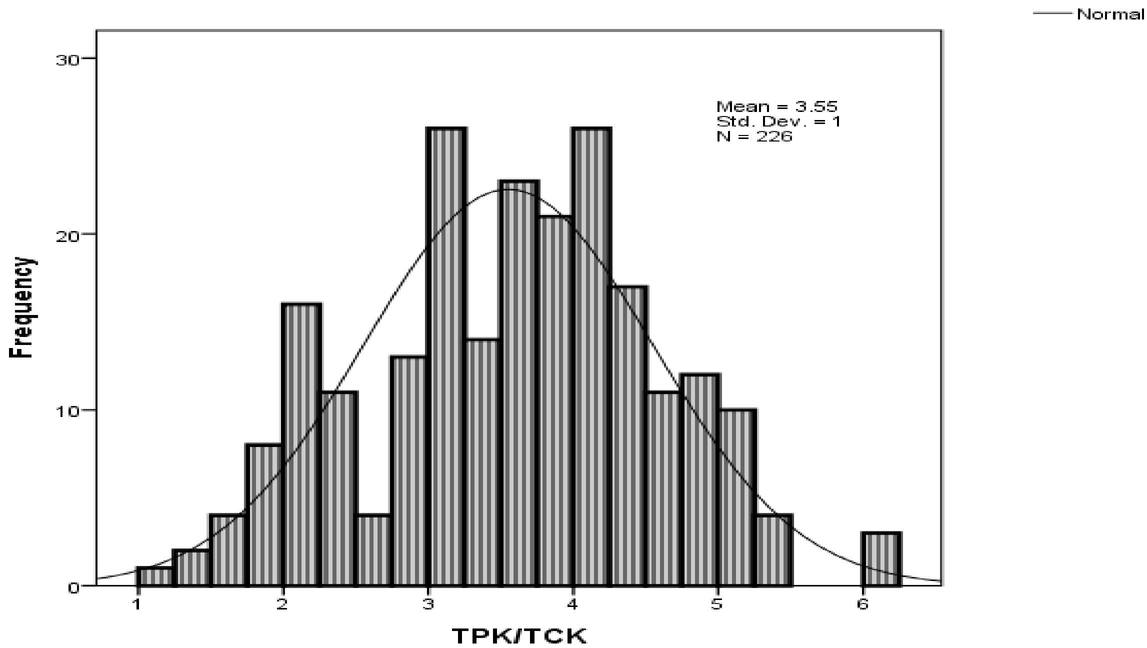


Figure 8. Distribution of scores on the TPK/TCK variable.

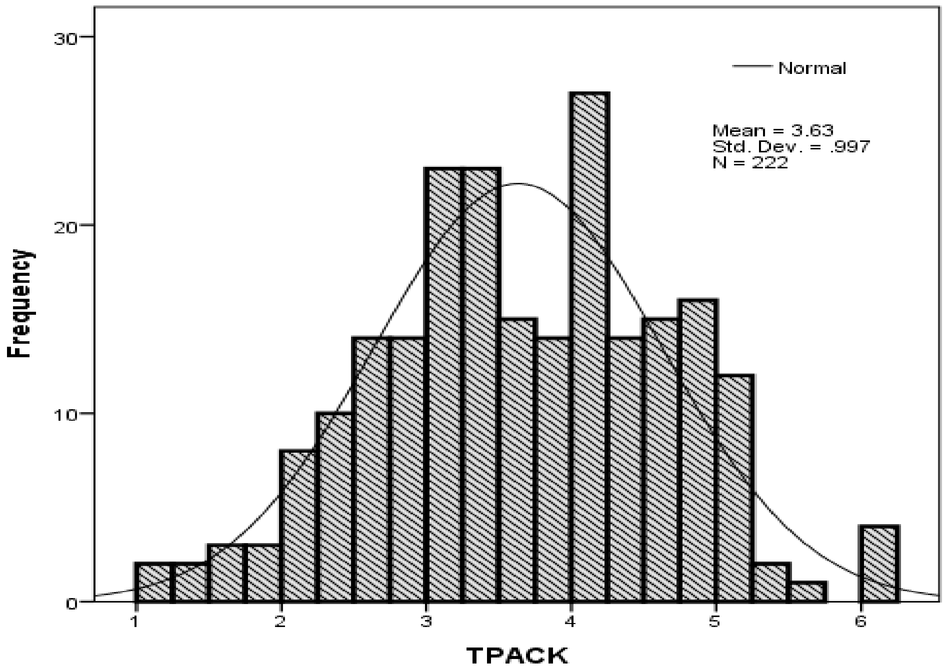


Figure 9. Distribution of scores on the TPACK variable.

3.12.2 Tests for outliers.

Observations of the boxplots generated by IBM SPSS reported no outliers for the TK, TPK/TCK and TPACK datasets as illustrated in Figure 10, Figure 11 and Figure 12.

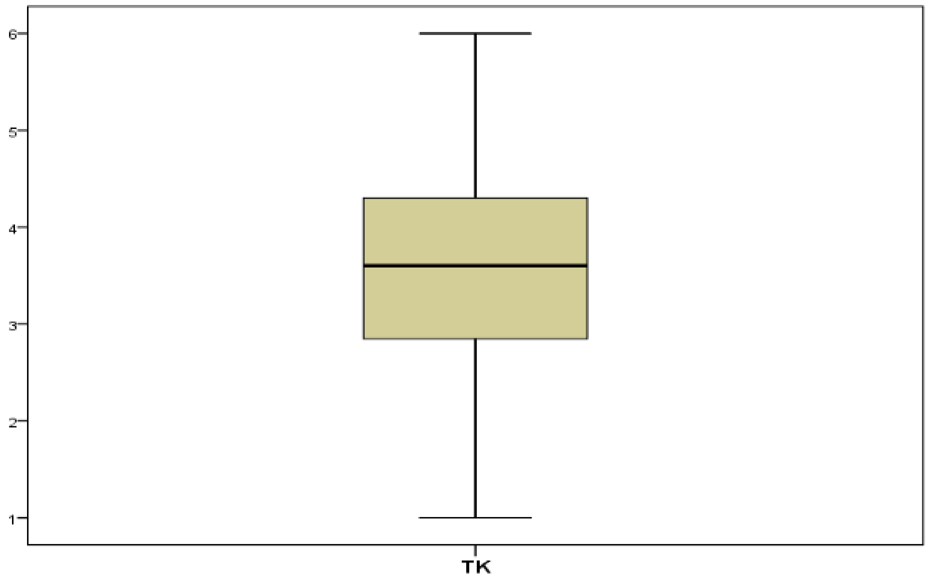


Figure 10. Box plot showing no outliers for TK.

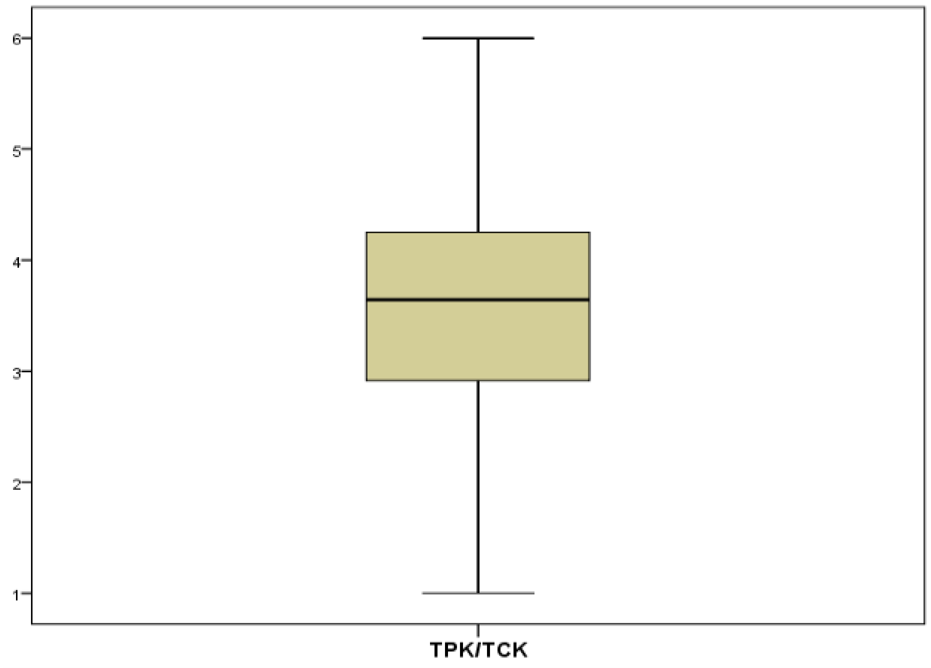


Figure 11. Box plot showing no outliers for TPK/TCK.

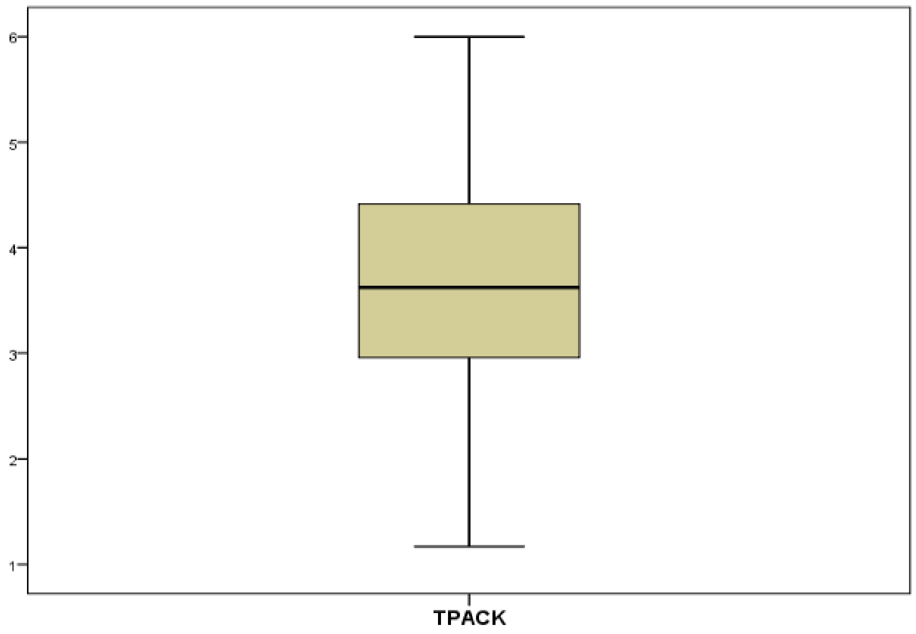


Figure 12. Box plot showing no outliers for TPACK.

3.12.3 Variance.

There was no violation for Levene's test of Equality of Error variances when independent-samples t-tests were conducted to compare in-service and pre-service teachers' mean scores for TK, TPK/TCK, and TPACK in Research Question 2. The *p* values (significant value) were > .05: TK = .59; TPK/TCK = .52; and TPACK = .25. This meant there was no violation for the assumption of equal variance for in-service and pre-service teachers. An example for the output generated by IBM SPSS for TK is illustrated in Table 8 and Table 9.

Table 8

Levene's Test for Equality of Error Variances - Group Statistics

		N	Mean	Std. Deviation	Std. Error Mean
TK	1 In-service	167	3.39	1.015	.079
	2 Pre-service	53	4.40	1.010	.139

Table 9

Independent Samples Test for TK

	Levine's Test for Equality of Variances		*t*-test for Equality of Means						
			t	*df*	*Sig*[a]	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the difference	
	F	*Sig*						Lower	Upper
Equal variances assumed	.04	.59	6.32	218	.000	-1.01	.160	-1.327	-.696
Equal variances not assumed			6.35	87.9	.000	-1.01	.159	-1.328	-.695

[a] 2-tailed.

3.12.4 Internal consistency and correlation.

The reliability of TK, TPK/TCK, and TPACK reported good internal consistency (George & Mallery, 2003). Cronbach's alpha coefficient for TK was .94, TPK/TCK was .98, and TPACK was .98. This meant the items which make up each scale measured the same underlying constructs. Appendix I displayed the case processing summary and reliability statistics for TPK/TCK and TPACK. An example of the reliability and case processing summary of the TK scale is outlined in Table 10 and Table 11.

Table 10

Reliability of the TK Scale - Case Processing Summary

Cases	N	%
Valid	213	94.2
Excluded[a]	13	5.8
Total	226	100.0

[a] List-wise deletion based on all variables in the procedure.

Table 11

Reliability of the TK Scale - Reliability Statistics for TK

Cronbach's Alpha	Number of Items
.94	12

Ensuring the data file was checked for accuracy, the following statistical analyses were computed: correlation; factor analysis; independent samples *t*-tests; analysis of variance (ANOVA); multivariate analysis of variance (MANOVA); *Cohen's d*, and Standard scores (*Z* scores).

3.12.5 Conversion of 7-point to 6-point on the Likert Scale.

Research Question 6 compares Australian and Trinidad and Tobago pre-service teachers' TPACK scores. Permission was sought and granted from Albion (personal communication, June 25, 2014) to utilise the results of the descriptive statistics for 20 items on the TPACK dataset from one Australian regional university which participated in the TTF TPACK survey in 2011. Pre-service teachers in Trinidad and Tobago responded to the same survey in 2013. Australian teachers responded on a 7-point Likert scale with anchors at 0 = not confident, and 6 extremely confident. On the other hand Trinidad and Tobago teachers responded to a 6-point Likert scale with anchors at 1 = not confident, and 6 =extremely confident. Hence comparison of the descriptive statistics of these two groups of teachers required conversion of data to comparable scales. Figure 13 presented the 6-point and 7-point scales aligned to show how the 2013 data were converted to the 6-point scale. Standard scores (*Z* scores) were then computed using an online calculator from the website (http://in-silico.net/tools/statistics/ztest).

2011 Australian University	Not confident			Moderately confident			Extremely confident
	0	1	2	3	4	5	6
2013 Trinidad and Tobago Universities	1	1.2	2.4	3.6	4.8		6

Figure 13. Conversion of a 7-point scale to a 6-point scale.

3.13 Qualitative Data Analysis Procedure

This section describes the processes involved in analysing the data qualitatively from semi-structured interviews. Before initial coding began, the researcher read two transcripts separately, one at a time (A, in-service teacher and B-pre-service teacher). This was done with the intention of developing meaning from the data and understanding the "big picture" in relation to two Research Questions, 7 and 8. In addition, two experienced teachers (who did not participate in the interviews) with over 20 years of pedagogical practices and who were familiar with the eConnect and Learn program in Trinidad and Tobago were purposefully invited to participate in the first set of manual coding. They were advised to read the photocopied transcripts first, and then re-read it again to highlight the important themes and categories that they found within the de-identified transcripts. Different colours of markers were used for this process. The most important themes and categories were written on sticky notes and tagged on the corresponding highlighted data. The volunteers were asked to view the data from a close as well as a distant perspective to maintain a balance form of exploration of the data. As they wrote the concepts and themes they were to question themselves, "Why is this information important" and "What theme and category were they linked to?" Eventually the sticky notes with similar themes and categories were grouped together and were compared with those of the researchers. This was necessary to provide validity and reliability of the first stage of the analysis process.

The same procedure was followed when the researcher returned to Australia by asking two additional volunteers from the University of Tasmania (UTAS) to code the same two photocopied transcripts. Themes and categories were compared from three sets of coding: the researcher, volunteers from Trinidad and Tobago and volunteers from the University of Tasmania. There was little variation in the general coding process. The terms used for identified themes and categories varied, for example, the category ‘collaboration’ was referred to as ‘discussion with peers’ or ‘meeting with teachers’. The volunteers were given tokens from the different countries for their assistance.

Insights were gained from the knowledge and practice from the previously manually coded transcripts. A modified form of Grounded Theory approaches (Strauss & Corbin, 1990), combined with thematic analysis and the NVIVO software were applicable for analysing the transcripts qualitatively and to facilitate the coding process. The modified form of thematic analysis is further described in Chapter 4 under Qualitative Analysis on page 139. Three coding strategies of Grounded Theory were utilized: Open, Axial and Selective. For Open Coding, the first transcript was read and reread at least two times before the coding process began. Every segment of the participant’s responses which captured the researcher’s attention was initially coded and analysed for its concepts and its meaning. Nodes were created in NVIVO and described according to the concepts and identified themes for the open-ended questions. Following the Strauss and Corbin's (1990) idea about coding, information which captured the actual expression/label of an interviewee was occasionally used as the title of the node. Coded information was ‘dragged and dropped’ to the relevant node which was set up according to each research question. This was the first level of interpretation where each component code was reviewed independently, creating a re-contextualized perspective on each concept or topic as all the coded text relating to it were brought together. Linked node, memos, and annotations were created if any of the topics or themes sparked insightful meanings. Open coding broke down, examined, compared, conceptualized, and categorized the data into nodes.

Open coding was followed by axial coding using the constant comparative method which is the process of finding similarities and differences, making connections between codes and data segments. New nodes were created through the application of different techniques. Repetitions were explored for useful concepts to use as a basis for nodes. The researcher used questions of the text (such as: who, what, why, how, how much, how long, what for, what if or with what results) (Bazeley & Jackson, 2013) related to the eConnect and Learn program to generate codes. The questioning techniques enabled the researcher to compare and contrast passages in the transcripts to discern the dimensions within concepts or unobserved data running through the text. Further, nodes were created through the examination of related coded data to each other to form categories. A coded paradigm involving conditions, context, action/interactional strategies and consequences was utilized. Also a priori codes (Patton, 2002; Strauss, 1987) which came from the researchers' prior reading about issues pertaining to the eConnect and Learn program were used as sensitizing concepts rather than fixed categories. The constant comparison method was used for the transcript until there was no new data to expand the category/categories.

Following axial coding was selective coding. This was a refinement process for all the categories and involved deliberately selecting specific data segments to fit into a previously generated category. The aim was to strengthen and clarify the categories. Relationships between the categories at this point were developed, which began to form a visual picture and interconnectedness for responses of the open-ended questions. Selective coding examined the process of selecting the core category, systematically relating it to other categories, validating those relationships, and filling in categories that needed further refinement and development. Themes were re-examined to determine whether they supported the data. After collecting additional data, the researcher continued to analyse and code the data, and use the insights from that analysis process to inform the next iteration of coding the second transcript, followed by all the others.

Using a modified form of coding strategies in Grounded theory contributed to the analysis of the qualitative data to underpin the research questions. Nodes were constructed and named according to each emerging concept discussed during the interview. Patterns, including similarities and differences, were identified in the codes, which were then collapsed into categories. They were compared and those with common attributes were further collapsed into over-arching themes. Themes were re-examined to determine whether they supported the data. The data were revisited to ensure analysis was completed.

3.14 Summary of Chapter 3

This chapter has presented the methodological approach utilised for this study. Divided into six sections, the chapter has provided detailed description about the selection of the research design, participants, ecological environment for the research, the validity and reliability of the instruments, as well as the collection and analysis of data. Data were collected for the eight research questions via the TK and TPACK survey instruments and semi-structured interviews. The survey instruments were analysed using descriptive and inferential statistics to provide an insight into the teachers' TPK/TCK, TPACK, and TK and allowed generalisations to be made from the specific sample. Interviews were compared, contrasted, analysed, and interpreted to provide a comprehensive detailed picture of the perception and impact of the eConnect and Learn program.

CHAPTER 4: RESULTS

4.1 Introduction

This chapter presents the results of the analyses of eight research questions based on data collected from the Technological Knowledge (TK) and Technological Pedagogical Content Knowledge (TPACK) survey instruments as well as from semi-structured interviews. Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK) were combined as TPK/TCK because items relating to the two constructs were designed on the same scale for confidence. Analyses through a mixed methods approach provided evidence, understanding, and insight on teachers' integration of the eConnect and Learn program for their pedagogical content practices. The combination of two different and contrasting approaches (quantitative and qualitative) provided richer analyses of the research questions from different perspectives than either approach alone. Comparative techniques such as teachers' confidence to integrate ICT, teaching experience, school category, qualification, and instructional content areas connected qualitative data with demographic, categorical and scaled values to compare subgroups in this project.

The chapter consists of two major sections. The first displays the statistical description of the sample demographic data for in-service and pre-service teachers. The second is structured around eight research questions, with all research findings discussed under the associated research question. Research Question 1 investigates the relationship of the scores obtained from the TK and TPACK survey instruments. Research Question 2 compares pre-service and in-service teachers' confidence to use ICT. Research Questions 3 and 4 examine the impact of teaching experience, school category, instructional content areas, and qualification on teachers' TK, TPK/TCK, and TPACK scores respectively. Research Questions 5 investigates the factor structure of teachers' surveys. Research Question 1 and 5 are purposefully and deliberately separated from each other to give the reader the opportunity to become familiar with the items of the survey instruments in Research Questions 2, 3, and 4. Research Question 6 positions Trinidad and Tobago pre-service teachers at an international level by comparing their TPACK scores with Australian pre-service teachers' TPACK scores. These six research questions are analysed quantitatively. The remaining two research questions are analysed qualitatively.

Research Question 7 utilises Moersch's (2010) Levels of Teaching Innovation to review and interpret teachers' interview data relating to their pedagogical practices. Research Question 8 sought participants' viewpoints on the implications for the future of the eConnect and Learn program. These two questions provide in-depth and contextualised insights to better understand, explain, and build on the results from the predictive power of the quantitative findings (Creswell & Clark, 2007) obtained from Research Questions 2, 3, 4, and 6. The following eight research questions will be used as a framework for this Chapter.

1. Based on the teachers' survey results, what is the relationship between teachers TK, TPK/TCK, and TPACK scores?
2. How confident are pre-service and in-service teachers to use ICT as determined by the TK, TPK/TCK and TPACK surveys?
3. Do teaching experience and school category impact upon in-service teachers' TK, TPK/TCK, and TPACK scores?
4. Do instructional content areas and qualifications impact upon pre-service and in-service teachers' TK, TPK/TCK, and TPACK scores?

5. What are the factor structures of the teacher' surveys?
6. What is the comparison of pre-service teachers TPACK scores from Australia and Trinidad and Tobago?
7. Can Moersch (2010) Levels of Teaching Innovation be used to review and interpret teachers' interview data relating to pedagogical practices with computers and related devices?
8. What implications are there for the future implementation of the eConnect and Learn program?

4.2 Demographic Data

Demographic data included the following categories:

- Gender
- Qualifications
- Teaching experience
- School type
- Instructional areas

4.2.1 Gender.

Inspection of the descriptive statistics output generated from SPSS confirmed 226 secondary school teachers from Trinidad and Tobago participated in the surveys. Among the sample, 173 (77%) were in-service teachers employed in 12 secondary schools and 53 (23%) were final year pre-service teachers from two campuses of the University of Trinidad and Tobago engaged in teacher education programs. Considering gender for the sample in the survey, the ratio of female participants to male participants for in-service teachers was 3:1 (75%:25%) whereas the ratio for pre-service teachers in the same category was 4:1(80%:20%). These findings are summarised in Table 12.

Table 12

Ratio of Gender for Participants in the Survey

Participants	Male	Female	Female : Male
In-service teachers (*n* = 173)	129 (75%)	44 (25%)	3:1
Pre-service teachers (*n* = 53)	47 (80%)	6 (20%)	4:1

Note. *N*=226.

The participants for the interview session consisted of 21 in-service teachers, 15 pre-service teachers, five technicians in the area of Information and Communications Technology (ICT); three school supervisors, and the Director of the eConnect and Learn program. This trend for gender in the sample for the interview sessions was almost as consistent as in the survey for in-service teachers, 3:1 (76%:24%) but changed slightly for pre-service teachers from 4:1 (80% to 20%) to approximately 3:1 (73% to 27%). What was interesting, the trend for ratio in gender of ICT technicians, schools supervisors, and the Director of the eConnect and Learn program deviated from the results previously found for the two cohorts of teachers. The ratio for gender of male participants was higher than female participants as tabulated in Table 13**.**

Table 13

Ratio of Gender for Participants in the Interview

Interviewed participants	Female	Male	Female : Male
In-service teacher (*n* = 21)	15 (76%)	6 (24%)	3:1
Pre-service teachers (*n* = 15)	11 (73%)	4 (27%)	3.1
ICT technicians (*n* = 5)	1 (20%)	4 (80%)	1:4
School supervisors (*n* = 3)	1 (33%)	2 (67%)	1:2
Director (n = 3)	1 (100%)	-	-

Note. *N*=44. Ratio and percentages are presented to the nearest whole number.

It can be concluded from an inspection of Table 12 and Table 13, that there were more female than male participants in the teaching profession. In contrast, the results differed in the administrative and technical positions where there were more male than female participants in the sample. This is generally representative of the population in the administrative and technical departments in Trinidad and Tobago.

The following section captures the descriptive statistics of the categories relating to in-service and pre-service teachers' qualifications, teaching experience, school type, and instructional area. Because ICT technicians, school supervisors, and the Director of the eConnect and Learn program participated only in the interview session, they were not required to complete a demographic sheet. Consequently, they were not represented on the graphs.

4.2.2 Qualification of participants.

In terms of qualification of participants in the survey, in-service teachers were employed at secondary schools and were categorised according to their certification. The largest number, 147 (66%), were certified with an undergraduate degree. The least number, 25 (11%) with the highest qualification, were those certified with a Master degree. On the other hand, pre-service teachers, 53 (23%), were in their final year at the two campuses of the University of Trinidad and Tobago aspiring to achieve an undergraduate degree for employment in secondary schools. They were specialising in one of the following disciplines: English, Maths, Science, or Social Studies. One pre-service and one in-service teacher did not include their qualifications. The distribution of participants by qualification is displayed in Figure 14.

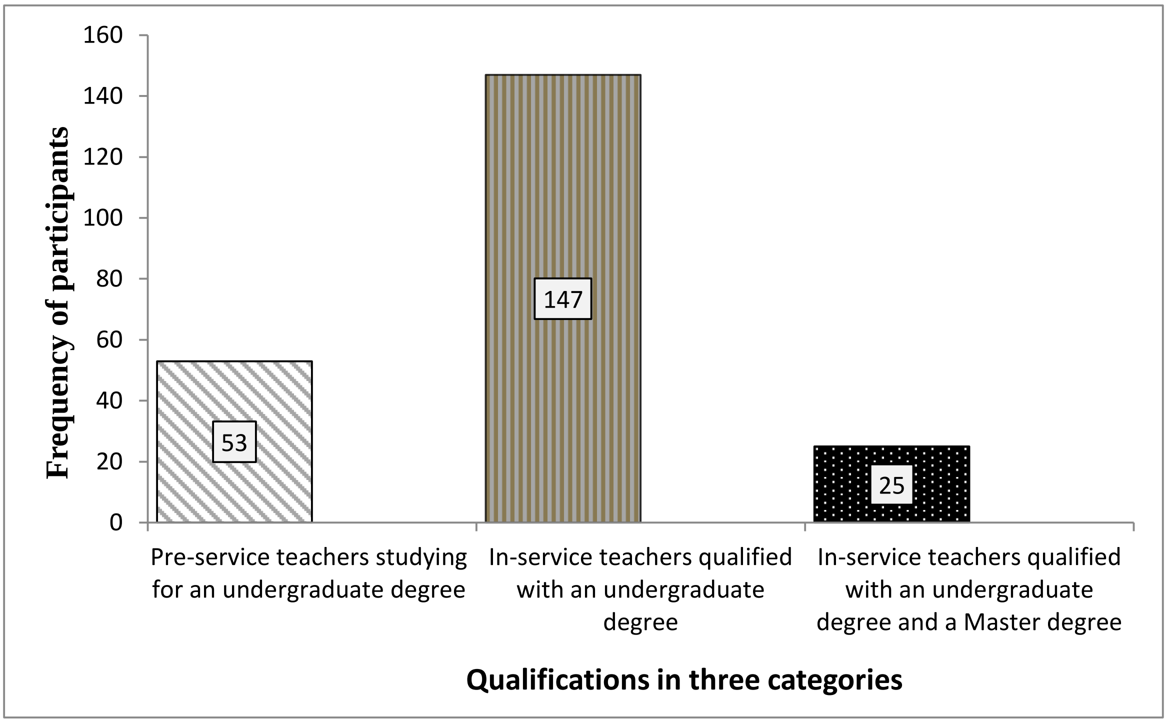


Figure 14. Frequency of participants by qualifications

4.2.3 Teaching experience.

Teaching experience of in-service teachers was recoded in four groups according to the number of years of their pedagogical practice. Teachers with experience of 1 to 5 years were recoded in Group 1; 6 to 10 years were recoded in Group 2; 11 to 15 years were recoded in Group 3; and >15 years of teaching experience were recoded in Group 4. The largest group of teachers by teaching experience were those in Group 3 with 11 to 15 years of experience across the sample of 172 in-service teachers (one teacher did not mention his/her years of teaching experience). The distribution of teachers for Groups 1, 2, and 4 were marginally the same. Pre-service teachers (*n* = 53) were not categorised in any of the four groups because their teaching experience was provided only during the teaching practicum in secondary schools (learning experience). The distribution of teaching experience for the entire sample is displayed in Figure 15.

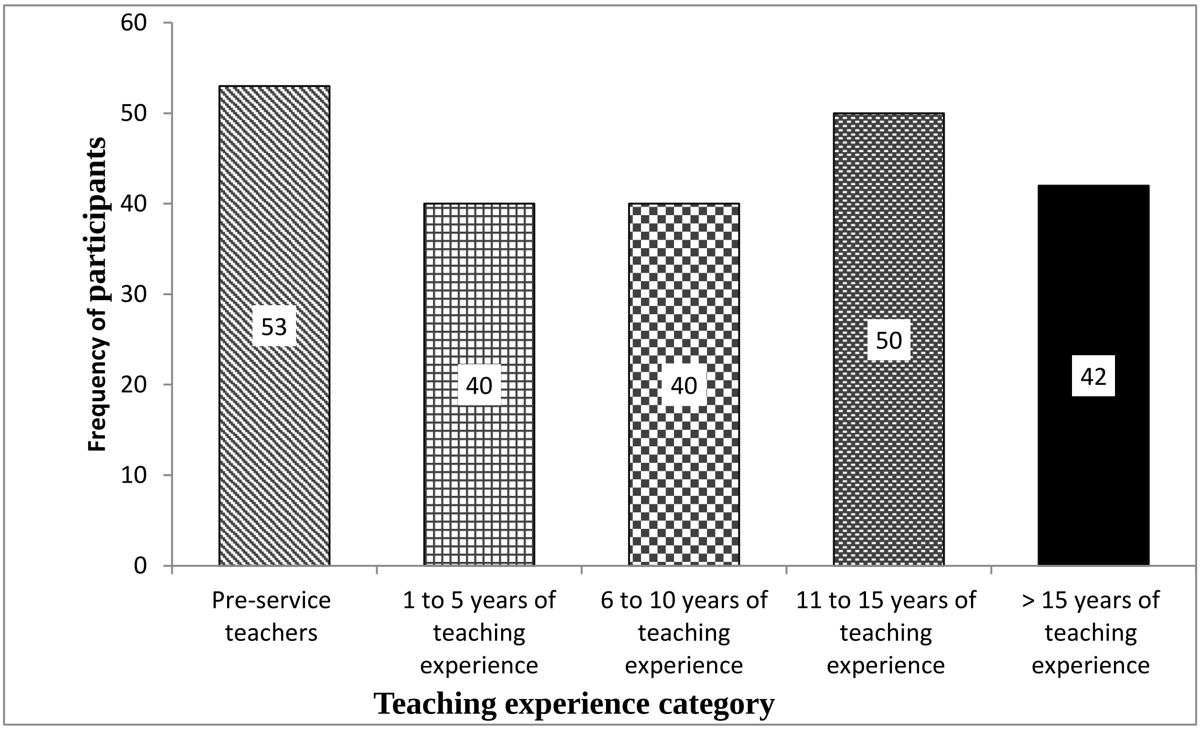


Figure 15. Frequency of participants by teaching experience

4.2.4 School type.

School type was recoded in three categories: government, denominational and university. The distribution across school category revealed 90 (40%) participants were from the government secondary schools; 83 (37%) from the denominational secondary schools; and 53 (23%) from the two campuses of the University of Trinidad and Tobago. The distribution for school type is displayed in Figure 16.

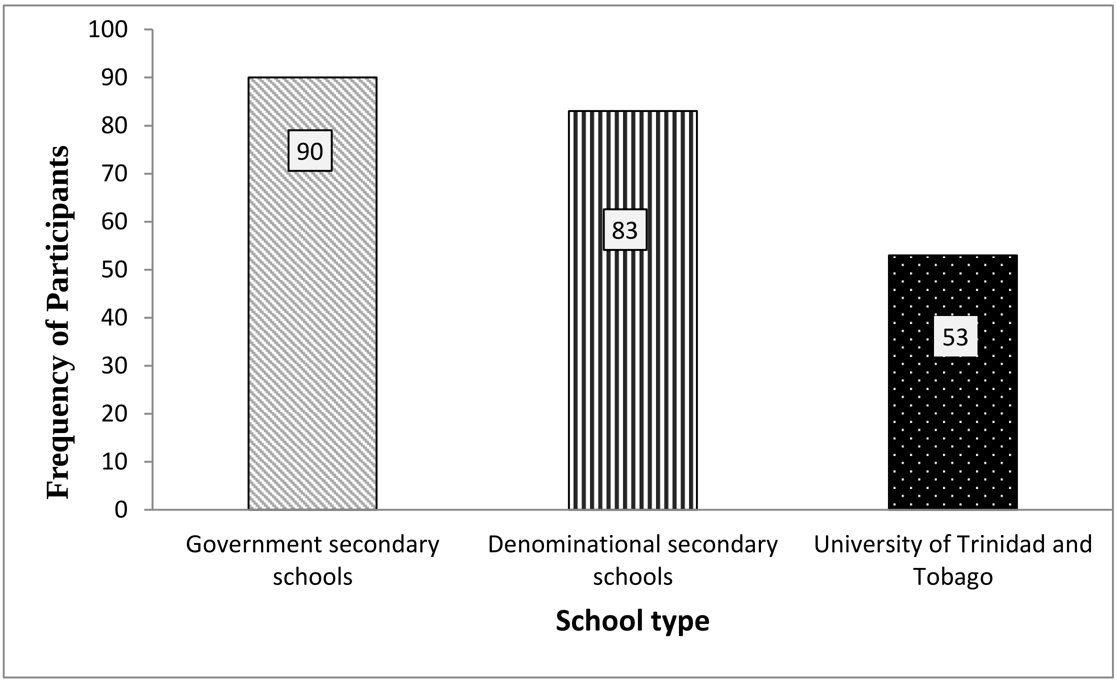


Figure 16. Frequency of participants by school category

4.2.5 Instructional content category.

The instructional content category was recoded in four groups: Maths, Science, Humanities and "Other." Physical Science and Life Science were recoded as Science. Languages (Spanish, French, and English), Business, Communication Studies, and Social Studies were recoded as Humanities. Food and Nutrition, Information Technology, Visual Arts, Physical Education, and Technical Vocations were recoded as "Other". The distribution of participants by instructional groups was 32 (16%) for Maths, 46 (22%) for Science, 96 (47%) for Humanities, and 30 (15%) for "Other." A total of 22 participants did not indicate their instructional groups in the demographic data. The distribution for instructional content category is displayed in Figure 17.

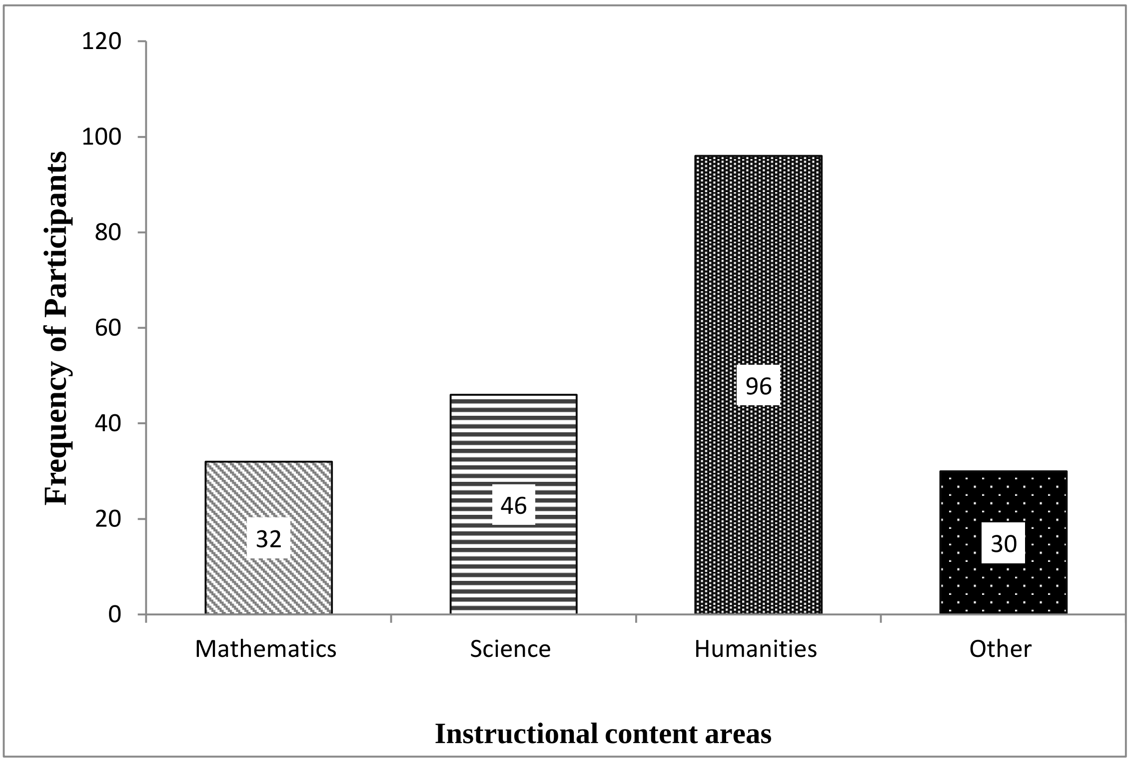


Figure 17. Frequency of participants by instructional content category

4.3 Analyses of Research Questions

This section consists of the eight research questions. The first six research questions (RQ) were analysed quantitatively by performing the following tests on the scores obtained from the survey instruments by pre-service and in-service teachers: relationship of TK, TPK/TCK, and TPACK scores (RQ 1); individual independent-samples *t*-tests (RQ 2); analysis of variance (RQ 3); multivariate analysis of variance (RQ 4); exploratory factor analysis (RQ 5); and *Z* test (RQ 6). Independent variables were: pre-service and in-service teachers, teaching experience, school categories, qualifications, and instructional content areas. Dependant variables were represented by participants' TK, TPK/TCK, and TPACK scores obtained from the surveys. In contrast, data collected from the semi-structured interviews for the last two research questions (RQ 7 and RQ 8) were analysed qualitatively.

4.4 Scatter Plots and Correlation Matrix

Research Question 1: *Based on teachers' survey results, what is the relationship between their TK, TPK/TCK, and TPACK scores?*

To describe the relationship based on the survey results from the three pairs of variables (TPK/TCK and TPACK; TK and TPK/TCK; and TK and TPACK) scatterplots of the scores were first generated, followed by the calculation of Pearson product-moment correlation coefficient. The scatterplots indicated the distribution of the data points were almost evenly spread on the line of best fit. Further examination revealed there was a positive linear relationship. Therefore it was hypothesised as teachers' confidence increased in technological knowledge, there was a corresponding increase in the development of technological pedagogical knowledge, technological content knowledge, and technological pedagogical content knowledge. The positive linear relationship of the variables is displayed in Figure 18, Figure 19 and Figure 20.

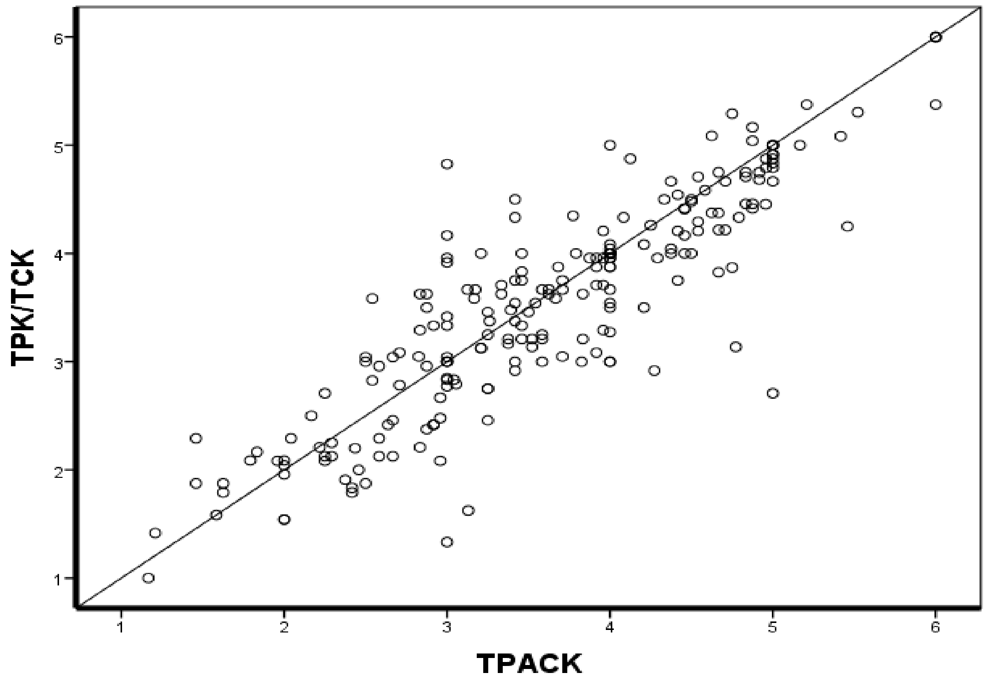


Figure 18. Scatterplot for the variables TPACK and TPK/TCK (N = 226; r = .88)

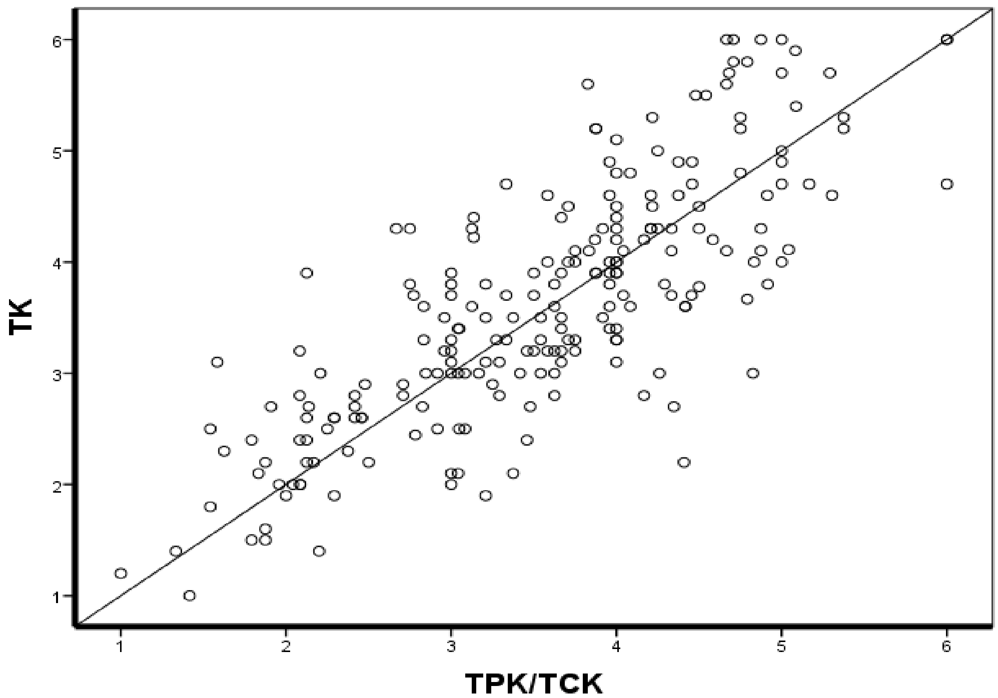


Figure 19. Scatterplot for the variables TK and TPK/TCK (N = 226; r = .79)

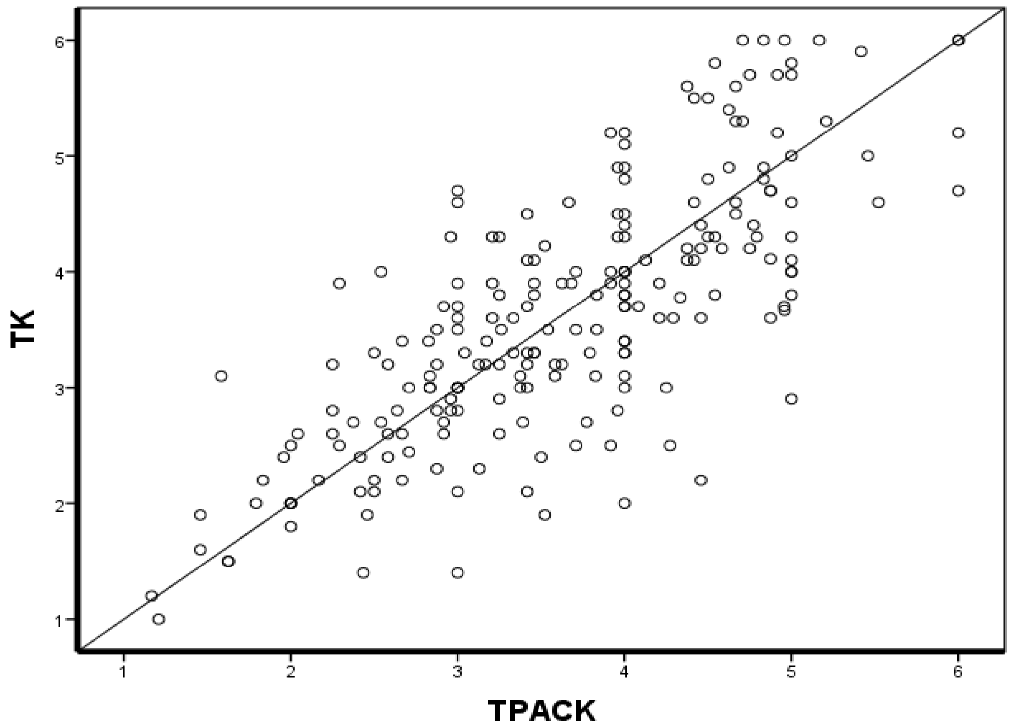


Figure 20. Scatterplot for the variables TK and TPACK (*N* = 226; *r* = .77)

Further inspection of Pearson's correlation coefficient revealed there was a strong relationship between each pair of variables. The highest was between TPK/TCK and TPACK (*r* = .88) followed by TK and TPK/TCK (*r* = .79) and TK and TPACK (*r* = .77). In each case the correlation was significant at .01 level. The shared variance for the variables ranged from 77% (TPK/TCK and TPACK) to 58% (TK and TPACK). The correlation of the three sets of variables is displayed in Table 14.

Table 14

Correlation Matrix for TPK/TCK, TPACK, and TK

	TPK/TCK	TPACK	TK
TPK/TCK	1		
TPACK	.88**	1	
TK	.79**	.77**	1

Note. (*N* = 226) **Correlation is significant at 0.01 level (2-tailed).

4.5 Independent-Samples *t*-tests

Research Question 2: *How confident are pre-service and in-service teachers to use ICT as determined by the TK, TPK/TCK and TPACK surveys?*

Individual independent-samples *t*-tests were conducted to analyse pre-service and in-service teachers' confidence to use ICT as specified on the items on the TK, TPK/TCK, and TPACK scales of the surveys. Responses to the items were made on a Likert scale from 1 = not confident, 2 = partially confident, 3 = moderately confident, 4 = confident, 5 = very confident, and 6 = extremely confident. *Cohen's d* was also computed to identify and verify the magnitude of the differences between the mean scores obtained in the independent-samples *t*-test for the two cohorts. According to Cohen (1988), .2 = small effect size, .5 = medium effect size, and .8 = large effect size. The URL, http://www.uccs.edu/~lbecker/, assisted in the calculation of *Cohen's d*. The main findings for each analysis will be presented before each table with its descriptive statistics, followed by the results for *Cohen's d*.

4.5.1 Independent-samples *t*-test for TK

Individual independent-samples *t*-tests (two-tailed) for items on the TK scale were conducted to investigate pre-service and in-service teachers' confidence to use 12 ICT devices. Table 15 demonstrated there was a statistically significant difference ($p = \leq .001$) between the value of mean scores for pre-service and in-service teachers. An inspection of the descriptive statistics revealed pre-service teachers obtained higher values for the mean scores than in-service teachers for each item on the TK survey. The results suggested pre-service teachers were more confident to use the 12 ICT devices as compared to in-service teachers. Based on the value of mean scores obtained from the independent-samples *t*-tests, pre-service teachers' highest rating of confidence to use ICT were achieved in the following items:

- Computers (*M* = 5.25).
- World Wide Web (*M* = 5.25).
- Multimedia devices (*M* = 5.13).
- Word Processing (*M* = 5.06).

In-service teachers' highest rating of confidence to use ICT were achieved in the following items:

- Computers (*M* = 4.27).
- World Wide Web (*M* = 4.21).
- Word Processing (*M* = 4.12).
- Digital/ Document camera (*M* = 3.88).

The lowest value of mean scores obtained for both cohorts were in the following items:

- Interactive whiteboard ($M_{pre\text{-}service}$ = 3.78; $M_{in\text{-}service}$ = 2.88).
- Webpage design ($M_{pre\text{-}service}$ = 3.71; $M_{in\text{-}service}$ = 2.45).
- Internal software ($M_{pre\text{-}service}$ = 3.69; $M_{in\text{-}service}$ = 2.93).
- External software ($M_{pre\text{-}service}$ = 3.68; $M_{in\text{-}service}$ = 2.96).

The difference in the highest value of mean scores for confidence to use ICT devices between pre-service (*M* = 5.25, *SD* = 1.00) and in-service teachers (*M* = 4.27, *SD* = 1.12) was approximately 1 point on the Likert scale. Similarly, the difference between the lowest value of mean scores for confidence to use ICT devices between pre-service teachers (*M* = 3.68, *SD* = 1.49) and in-service teachers (*M* = 2.45, *SD* = 1.30) differed by approximately 1 point. The 1-point difference was important to better explain teachers' confidence to use ICT devices on the 6-point Likert scale. Using 3.5 as the midpoint point on the Likert scale, confidence to use ICT for pre-service teachers were within the range of moderately confident to very confident whereas in-service teachers were within the range of partially confident to confident. Table 15 provides the results for the *t*-tests and the values for *Cohen's d* for TK.

Table 15

Significant Difference Between Pre-service and In-service Teachers' TK

How confident are you to use the following ICT devices?	Teacher	*M*	*SD*	*t*	*df*	*p*	*Cohen's d* value
Computer	PS	5.25	1.00	5.77	224	.001	0.90 # # #
	IS	4.27	1.15				
World Wide Web	PS	5.25	1.04	5.58	224	.001	0.56 # #
	IS	4.21	1.22				
Multi-media devices	PS	5.13	1.00	7.02	222	.001	1.18 # # #
	IS	3.78	1.28				
Word Processing	PS	5.06	1.25	4.77	222	.001	0.75 # #
	IS	4.12	1.26				
Digital camera/document camera	PS	4.85	1.29	4.57	224	.001	0.73 # #
	IS	3.88	1.37				
Spread sheet	PS	4.47	1.37	4.83	223	.001	0.76 # #
	IS	3.42	1.39				
Databases	PS	4.38	1.40	5.31	223	.001	0.83 # # #
	IS	3.24	1.35				
Digital video for production and editing	PS	4.32	1.53	5.90	221	.001	0.91 # # #
	IS	2.98	1.42				
Interactive whiteboard	PS	3.79	1.79	3.39	223	.001	0.56 # #
	IS	2.88	1.46				
Webpage design	PS	3.71	1.61	5.69	221	.001	0.85 # # #
	IS	2.45	1.33				
Internal software	PS	3.69	1.54	3.51	217	.001	0.51 # #
	IS	2.93	1.30				
External software	PS	3.68	1.49	3.34	218	.001	0.51 # #
	IS	2.96	1.33				

Note. *N=226*. $p \leq .001$, two - tailed; PS-Pre-service teachers, IS-In-service teachers; # indicates small effect size; # # indicates a moderate to large effect size; # # # indicates a large effect size.

Table 15 indicated the largest effect size occurred in five (42%) items: multi-media devices (*d* =1.18); digital video for production and editing (*d* = 0 .91); computers (*d* = 0.90); webpage design (*d* = 0.85); databases (*d* = 0.83). The other seven items demonstrated a moderate to large effect size: internal software (*d* = 0.51), external software (*d* = 0.51), interactive whiteboard (*d* = 0.56), World Wide Web (*d* = 0.56), digital/document camera (*d* = 0.73), word processing (*d* = 0.75, spread sheet (*d* = 0.76).

4.5.2 Independent-samples *t*-tests for TPK/TCK

Individual independent-samples t-tests were conducted to investigate pre-service and in-service teachers' confidence to use ICT for the tasks specified by each item on the TPK/TCK scale. Table 16 demonstrated there was a statistically significant difference, ($p = \leq .001$) between pre-service and in-service teachers' mean scores. An inspection of the results of the descriptive statistics revealed pre-service teachers had higher value of mean scores than in-service teachers for each item on the scale**.** Based on the value of the mean scores obtained in Table 16, pre-service teachers' highest ratings for confidence to use ICT for the tasks specified by the items on the TPK/TCK scale were:

- Select and use a variety of digital media and formats to communicate information (*M* = 4.66).
- Use a range of ICT resources and devices for professional purposes (*M* = 4.54).
- Select and organize digital content and resources (*M* = 4.48).
- Use ICT to teach content areas in creative ways (*M* = 4.43).

In-service teachers' highest ratings for confidence to use ICT for the tasks specified by the items on the TPK/TCK scale were:

- Teach their specific subject/s in creative ways (*M* =3.80).

- Design lesson plans and assessments that incorporate ICT use by students (*M* = 3.64).
- Select and use a variety of digital media and formats to communicate information (*M* = 3.65).
- To access, record, manage, and analyse student record data (*M* = 3.59).

Pre-service teachers' lowest ratings for confidence to use ICT for supporting the tasks specified by the items on the TPK/TCK scale were:

- Demonstrate how ICT can be used to support numeracy learning (*M* = 3.69).
- Be aware of digital citizenship to promote student demonstration of rights and responsibilities in using digital resources and tools (*M* = 3.70).
- Teaching strategies to support students from disadvantaged backgrounds (*M* = 3.77).
- Manage challenging student behaviour by encouraging the responsible use of ICT (*M* = 3.77).

In-service teachers' lowest ratings for confidence to use ICT for supporting the tasks specified by the items on the TPK/TCK scale were:

- Engage parents and families in their child's schooling through ICT (*M* = 2.87).
- Be aware of digital citizenship to promote student demonstration of rights and responsibilities in using digital resources and tools (*M* = 2.92).
- Manage challenging student behaviour by encouraging the responsible use of ICT (*M* = 2.98).
- Use ICT to collaborate for professional purposes, such as online professional (*M* = 3.12).

The common item which both cohorts achieved high rating for confidence to use ICT on the TPK/TCK scale was:

- To use ICT to design lesson plans and assessments that incorporated ICT use by students ($M_{pre\text{-}service}$ = 4.62; $M_{in\text{-}service}$ = 3.64).

The common item which both cohorts of teachers achieved low rating for confidence to use ICT on the TPK/TCK scale was:

- To manage challenging student behaviour by encouraging the responsible use of ICT ($M_{pre\text{-}service}$ = 3.77; $M_{in\text{-}service}$ = 2.98

An inspection of the results of the descriptive statistics in Table 16 indicated the difference of the value of the highest mean score on the TPK/TCK scale between pre-service teachers (*M* = 4.66, *SD* = 1.09) and in-service teachers (*M* = 3.80; *SD* = 1.05) differed by almost 1 point. The value of the lowest mean scores on the TPK/TCK scale between pre-service teachers (*M* = 3.70, *SD* = 1.25) and in-service teachers (*M* = 2.87, *SD* = 1.15) also differed by almost 1 point. What was interesting, the rating for confidence of pre-service teachers' lowest value of mean score (*M* = 3.70, *SD* = 1.25), was almost as the same as in-service teachers' highest value of mean score (*M* = 3.80; *SD* = 1.05). Using 3.5 as the midpoint point on the Likert scale, pre-service teachers' confidence to use ICT for the items specified by the TPK/TCK scale were within the range of moderately confident to very confident whereas in-service teachers' confidence to use ICT for the items specified on the same scale were within the range of partially confident to confident. Table 16 provides the results of the individual independent-samples *t*-tests for items on the TPK/TCK scale and the values for *Cohen's d*.

Table 16

Significant Difference Between Pre-service and In-service Teachers' TPK/TCK

How confident are you to use ICT to perform the following tasks?	Teacher	*M*	*SD*	*t*	*df*	*p*	*Cohen's d* value
Demonstrate knowledge of a range of ICT to engage students.	PS IS	3.89 3.50	1.05 1.04	2.32	222	.020	.37 #
Use ICT and teaching strategies that are responsive to students' diverse backgrounds.	PS IS	4.02 3.45	1.01 0.98	3.64	223	.001	.57 # #
Use ICT and teaching strategies that are responsive to students' learning styles.	PS IS	4.02 3.45	0.93 0.98	3.78	217	.020	.60 # #
Use ICT and teaching strategies to support students from disadvantage backgrounds.	PS IS	3.77 3.14	0.95 1.10	3.67	219	.001	.61 # #
Use ICT and teaching strategies to plan individualized learning activities for students.	PS IS	4.08 3.31	1.09 1.09	4.36	218	.001	.70 # #
Use ICT to access, record, manage, and analyse student record data.	PS IS	4.35 3.59	1.20 1.21	4.00	223	.001	.63 # #
Use ICT to teach your specific subject/s in creative ways.	PS IS	4.43 3.80	0.95 1.05	3.83	224	.001	.63 # #
Design lesson plans and assessments that incorporate ICT use by students.	PS IS	4.62 3.64	1.06 1.15	5.50	224	.001	.89 # # #
Select and organize digital content and resources.	PS IS	4.48 3.57	0.96 1.20	4.93	223	.001	.84 # # #
Use ICT for reporting purposes, such as reporting to parents/carers.	PS IS	4.14 3.34	1.31 1.24	3.90	220	.001	.63 # #
Demonstrate how ICT can be used to support literacy learning.	PS IS	3.98 3.12	1.03 1.15	4.80	223	.001	.79 # #
Demonstrate how ICT can be used to support numeracy learning.	PS IS	3.69 3.12	1.09 1.16	2.82	222	.005	.51 # #
Design ICT activities that enable students to become active participants in their own learning.	PS IS	4.35 3.37	1.20 1.19	6.03	222	.001	.82 # # #
Select and use a variety of digital media and formats to communicate information.	PS IS	4.66 3.65	1.09 1.10	5.88	224	.001	.92 # # #
Engage parents and families in their child's schooling through ICT.	PS IS	3.90 2.87	1.30 1.15	5.42	220	.001	.83 # # #

How confident are you to use ICT to perform the following tasks?	Teacher	*M*	*SD*	*t*	*df*	*p*	*Cohen's d* value
Manage challenging student behaviour by encouraging the responsible use of ICT.	PS IS	3.77 2.98	1.06 1.17	4.37	222	.001	.71 # #
Be aware of digital citizenship to promote student demonstration of rights and responsibilities in using digital resources and tools.	PS IS	3.70 2.92	1.25 1.21	4.03	223	.001	.63 # #
Identify personal and professional learning goals in relation to using ICT.	PS IS	4.04 3.20	1.14 1.10	4.77	223	.001	.74 # #
Reflect on relevant ICT research to inform professional practice.	PS IS	4.04 3.19	0.98 1.16	5.22	222	.031	.80 # # #
Use a range of ICT resources and devices for professional purposes.	PS IS	4.54 3.43	1.00 1.12	6.44	223	.001	1.05 # # #
Use ICT to engage with colleagues to improve professional practice.	PS IS	4.37 3.26	1.14 1.10	6.21	222	.001	.99 # # #
Use ICT to collaborate for professional purposes, such as online professional communities.	PS IS	4.31 3.12	1.09 1.15	6.47	221	.001	1.06 # # #
Evaluate how ICT use has helped to achieve specific subject area goals.	PS IS	4.38 3.16	0.97 1.13	7.01	223	.001	1.25 # # #
Demonstrate an understanding of safe, legal and ethical use of digital information and technologies.	PS IS	4.30 3.23	1.22 .89	5.69	224	.001	.89 # # #

Note. $p < .001$, 2- tailed; PS - Pre-service teachers, IS- In-service teachers; # indicates small effect size; # # indicates a moderate to large effect size; # # # indicates a large effect size.

Table 16 indicated the largest effect size of the mean scores for both cohorts occurred in 11 items of the TPK/TCK scale. Four of these were:

- Evaluate how ICT use has helped to achieve specific subject area goals (d = 1.25).
- Use ICT to collaborate for professional purposes, such as online professional communities (d = 1.06).
- Use a range of ICT resources and devices for professional purposes (d = 1.05).
- Use ICT to engage with colleagues to improve professional practice (d = .99).

A moderate to large effect size occurred in 12 (50%) items of the same scale. The following four items illustrated these differences:

- Demonstrate how ICT can be used to support literacy learning (*d* = .79).
- Identify personal and professional learning goal in relation to using ICT (*d* = .74).
- Manage challenging student behaviour by encouraging the responsible use of ICT (*d* = .71).
- Use ICT and teaching strategies to plan individualized learning activities for students (*d* = .70).

Only one item (4%) obtained a small effect size. It was:

- Demonstrate knowledge of a range of ICT to engage students (*d* = .37).

4.5.3 Independent-samples *t*-tests for TPACK

Individual independent-samples *t*-tests were conducted to investigate pre-service and in-service teachers' confidence to use ICT to support their students' learning with ICT as determined by the items on the TPACK scale. An inspection of Table 17 revealed there was a statistically significant difference ($p = \leq .001$) between the value of the mean scores for pre-service and in-service teachers. A review of the descriptive statistics indicated pre-service teachers obtained a higher value for mean scores than in-service teachers for each item on the TPACK scale**.** Based on the value of the mean scores obtained, pre-service teachers' highest ratings for confidence to use ICT to support their students' learning with ICT were demonstrated by the following items:

- To integrate different digital media to create appropriate projects (*M* = 4.72).
- To engage in activities of the learning process (*M* = 4.70).
- To gather information and communicate with a known audience (*M* = 4.68).
- To communicate with others locally and globally (*M* = 4.64).

On the other hand, in-service teachers' highest ratings for confidence to use ICT and support their students' learning with ICT were demonstrated by the following items:

- To develop competencies in their subject area/s (M = 3.62).
- To engage in activities of the learning process (M = 3.56).
- To communicate with others locally and globally (M = 3.55).
- To demonstrate what they have learned (M = 3.51).

Pre-service teachers' lowest ratings for confidence to use ICT and support their students' learning with ICT on the TPACK scale were demonstrated by the following items:

- To engage in sustained involvement with curriculum activities (M = 4.02).
- To analyse their knowledge (M = 4.00).
- To critically interpret and evaluate the worth of ICT-based content for specific subject area/s (M = 4.00).
- To synthesize their knowledge (M = 3.96).

On the other hand, in-service teachers' lowest ratings for confidence to use ICT and support their students' learning with ICT were demonstrated by the following items:

- To critically evaluate their own and society's value (M = 3.18).
- To facilitate the integration of curriculum areas to construct multidisciplinary knowledge (M = 3.18).
- To critically interpret and evaluate the worth of ICT-based content for specific subject area/s (M = 3.12).
- To provide motivation for curriculum tasks (M = 2.79).

The common items which both cohorts of teachers achieved high ratings for confidence to use ICT and support their students' learning with ICT on the TPACK scale were:

- To engage in activities of the learning process ($M_{pre\text{-}service}$ = 4.70; $M_{in\text{-}service}$ = 3.56).
- To communicate with others locally and globally ($M_{pre\text{-}service}$ = 4.64; $M_{in\text{-}service}$ = 3.55).

The common item which both cohorts of teachers achieved low rating for confidence to use ICT and support their students' learning with ICT on the TPACK scale was:

- To critically interpret and evaluate the worth of ICT-based content for specific subject area/s ($M_{pre\text{-}service}$ = 4.00; $M_{in\text{-}service}$ = 3.12).

An inspection of the results of the descriptive statistics revealed the difference between the value of the highest mean score for pre-service teachers (M = 4.72, SD = 0.97) and in-service teachers (M = 3.62, SD = .97) was exactly 1 point on the TPACK scale. There was a slight difference (0.35) between the lowest value of mean scores of pre-service teachers (M = 3.14, SD = 0.77) and in-service teachers (M = 2.79, SD = 1.88). Using 3.5 as the midpoint point on the Likert scale, pre-service teachers' confidence to use ICT and support their students' learning with ICT for the items on the TPACK scale were within the range of moderately confident to very confident whereas in-service teachers' confidence to use ICT on the same scale were within the range of partially confident to confident. Table 17 provides results of the independent-samples *t*-test on the TPACK scale and the values of *Cohen's d*. The results of *Cohen's d* will be discussed after the presentation of Table 17.

Table 17

Significant Difference Between Pre-service and In-service Teachers' TPACK.

How confident are you to use ICT to support your students' learning with ICT in the following?	Teacher	*M*	*SD*	*t*	*df*	*p*	*Cohen's d value*
To provide motivation for curriculum tasks	PS IS	3.14 2.79	0.77 0.88	2.58	221	.011	.42#
To develop competencies in your subject area/s	PS IS	4.40 3.62	0.98 0.96	5.14	220	.001	.80# # #
To actively construct knowledge that integrates curriculum areas	PS IS	4.32 3.44	0.98 1.02	5.50	220	.001	.88# # #
To actively construct their own knowledge in collaboration with their peers and others	PS IS	4.38 3.41	1.10 1.04	5.82	220	.001	.91# # #
To analyse their knowledge	PS IS	4.00 3.41	1.02 1.03	3.67	220	.001	.58# #
To synthesize their knowledge	PS IS	3.96 3.38	1.02 1.05	3.55	220	.001	.56# #
To demonstrate what they have learned	PS IS	4.25 3.51	1.05 0.93	4.92	220	.001	.76# #
To acquire the knowledge, skills, abilities and attitudes to deal with on-going technological change	PS IS	4.15 3.29	1.08 1.09	5.04	220	.001	.80# # #
To integrate different digital media to create appropriate projects	PS IS	4.72 3.45	0.97 1.07	7.62	221	.001	1.23# # #
To develop rich understanding about a topic of interest relevant to the curriculum area/s being studied	PS IS	4.40 3.45	0.88 1.01	6.11	221	.001	1.00# # #
To engage in activities of the learning process	PS IS	4.70 3.56	0.95 1.00	7.27	220	.001	1.16# # #
To develop understanding of the world	PS IS	4.52 3.48	0.96 1.05	6.39	220	.001	1.03# # #
To plan and/or manage assigned curriculum projects	PS IS	4.21 3.37	1.07 1.06	5.08	221	.001	.82# # #
To engage in sustained involvement with curriculum activities	PS IS	4.02 3.32	0.95 1.09	4.18	220	.001	.68# #

How confident are you to use ICT to support your students' learning with ICT in the following?	Teacher	*M*	*SD*	*t*	*df*	*p*	*Cohen's d value*
To undertake formative and/or summative assessment	PS IS	4.54 3.41	0.70 1.06	8.91	220	.001	1.25# # #
To engage in independent learning through access to education at a time, place and pace of their own choosing	PS IS	4.16 3.27	1.05 1.00	5.43	216	.001	.87# # #
To gain intercultural understanding	PS IS	4.53 3.33	.85 1.05	7.60	221	.001	1.26# # #
To acquire awareness of the global implications of ICT-based technologies on society	PS IS	4.33 3.23	0.99 1.08	6.50	218	.001	1.06# # #
To communicate with others locally and globally	PS IS	4.64 3.55	1.09 1.07	6.46	221	.001	1.00# # #
To understand and participate in the changing knowledge economy	PS IS	4.15 3.22	1.06 1.05	5.62	220	.001	.88# # #
To critically evaluate their own and society's values	PS IS	4.11 3.18	1.01 1.09	5.53	220	.001	.88# # #
To facilitate the integration of curriculum areas to construct multidisciplinary knowledge	PS IS	3.91 3.18	0.97 1.12	4.27	220	.001	.70# #
To critically interpret and evaluate the worth of ICT-based content for specific subject area/s	PS IS	4.00 3.12	1.04 1.14	5.00	220	.001	.81# # #
To gather information and communicate with a known audience	PS IS	4.68 3.41	1.01 1.13	7.34	218	.001	1.18# # #

Note: N=226. p < .001, 2- tailed; PS-Pre-service teachers; IS-In-service teachers; # indicates a small to moderate effect size; # # indicates a moderate to large effect size; # # # indicates a large effect size.

Table 17 indicated the largest effect size occurred in 18 items. Four of these were:

- To gain intercultural understanding (*d* = 1.26).
- To undertake formative and/or summative assessment (*d* = 1.25).
- To integrate different digital media to create appropriate projects (*d* = 1.23).

- To engage in activities of the learning process (*d* = 1.16).

There were five (21%) items which demonstrated effect size ranging from moderate to large. Among these, two focussed on curriculum issues:

- To facilitate the integration of curriculum areas to construct multidisciplinary knowledge (*d* = .70).
- To engage in sustained involvement with curriculum activities (*d* = .68).

The other three were knowledge-based related:

- To analyse their knowledge (*d* = .58).
- To synthesize their knowledge (*d* = .56).
- To demonstrate what they have learned (*d* = .76).

Only one (4%) item reported an effect size ranging between small to moderate.

- To provide motivation for curriculum tasks (*d* = .42).

4.5.4 Bringing together the results of independent-samples *t*-tests.

The individual independent-samples *t*-test and *Cohen's d* brought together reliable information and evidence to suggest pre-service teachers were more knowledgeable and confident than in-service teachers to use ICT for their pedagogical practices and to support their future students learning with ICT. Overall the findings indicated pre-service teachers' confidence for TK, TPK/TCK, and TPACK were within the range of moderately confident to very confident on the Likert scale. In contrast, in-service teachers' confidence were within the range of partially confident to confident on the Likert scale. Box plots were generated to capture the comparison of pre-service and in-service teachers' scores for TK, TPK/TCK, and TPACK on the 6-point Likert scale in Figure 21. One outlier is acknowledged.

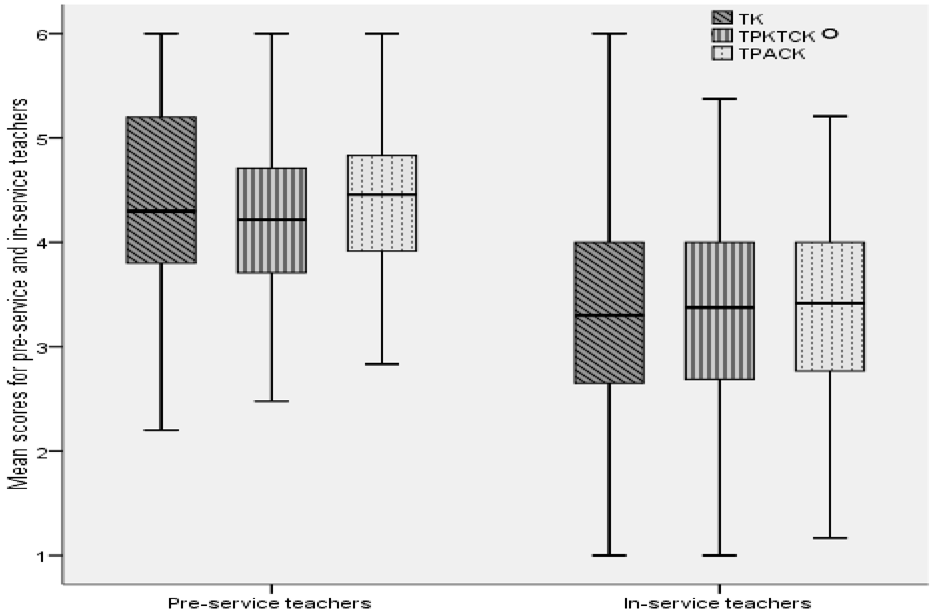


Figure 21. Box plots to compare teachers' TK, TPK/TCK and TPACK scores.

4.6 Analysis of Variance (ANOVA)

Research Question 3: *Do teaching experience and school category impact upon teachers' TK, TPK/TCK, and TPACK scores respectively?*

Three separate two-way analysis of variance (ANOVA) were conducted to explore the impact of teaching experience and school category on in-service teachers' TK, TPK/TCK, and TPACK scores obtained from the surveys respectively. Pre-service teachers were excluded in these analyses because they were still undergoing teaching experience (learning experience) during the final year of their undergraduate degree. In-service teachers were grouped according to their years of teaching experience. Group 1 teachers had 1 to 5 years of teaching experience. Group 2 teachers had 6 to 10 years of teaching experience. Group 3 teachers had 11 to 15 years of teaching experience. Group 4 teachers had more than 15 years of teaching experience. School category included denominational schools and government schools.

4.6.1 Impact of teaching experience and school category on teachers' TK scores.

A two-way analysis of variance was conducted to examine the impact of teaching experience and school category on in-service teachers' TK scores. An inspection of the results indicated there was no interaction effect for school category, F (3,158) = 1.92, p = .13. There was a statistically significant main effect for teaching experience, F (3, 158) = 7.34, p = <.001 with a large effect size (partial eta squared (η^2) = .12). Post hoc comparison of teaching experience using the Scheffe test indicated the mean scores for teachers in Group 1 who had 1 to 5 years' teaching experience (M = 3.60, SD = .92) and Group 2 who had 6 to 10 years of teaching experience (M = 3.83, SD = 1.00) differed significantly from teachers in Group 4 (M = 2.69, SD = 0.87) who had more than 15 years of teaching experience in secondary schools. There was no statistically significant difference for Group 3 teachers (M = 3.22; SD = 0.97). School category did not reach statistical significance (p > .05).

4.6.2 Impact of teaching experience and school category on teachers' TPK/TCK scores.

A two-way analysis of variance was conducted to examine the impact of teaching experience and school category on in-service teachers' TPK/TCK scores. An inspection of results indicated there was no interaction effect for school category F (3,164) = 1.28, p = .3 for TPK/TCK. There was a statistically significant main effect for teaching experience, F (3,164) = 3.43, p = .02 with a moderate effect size (partial η^2 = .06). Post hoc comparison of teaching experience using the Scheffe test indicated the mean scores for Group 1 teachers who had 1 to 5 years of teaching experience (*M* = 3.92, *SD* = .80) differed significantly from Group 3 (*M* = 3.03, *SD* = .97) teachers who had 10 to 15 years of teaching experience and Group 4 (*M* = 3.12; *SD* = .98) teachers who had more than 15 years of teaching experience. Group 2 (*M* = 3.42; *SD* = 1.01) teachers who had 6 to 10 years of teaching experience did not differ significantly from the three groups. School category did not reach statistical significance (*p* > .05).

4.6.3 Impact of teaching experience and school category on teachers' TPACK scores.

A two-way analysis of variance was conducted to examine the impact of teaching experience and school category on in-service teachers' TPACK scores. An inspection of results indicated there was an interaction effect between teaching experience and school category *F* (3,160) = 3.30, *p* = .02. There was a statistically significant main effect for teaching experience, *F* (3, 160) = 3.50, *p* = .02 with a moderate effect size (partial η^2= .06). Post hoc comparison using the Scheffe test indicated Group 1 teachers who had 1 to 5 years of teaching experience (*M* = 4.20, *SD* = .76) were significantly different from those in Group 3 (*M* = 3.29, *SD* = .96) who had between 11 to 15 years of teaching experience and Group 4 (*M* = 3.21, *SD* = 1.05) teachers who had more than 15 years of teaching experience. Group 2 did not differ significantly (*M* = 3.53; *SD* = .96). School category did not reach statistical significance (*p* > .05).

Figure 22 brings together the mean scores of the descriptive statistics for the three ANOVA. The results were deliberately represented in a clustered bar graph to make meaningful visual comparisons of the mean scores of teaching experience for in-service teachers' TK, TPK/TCK and TPACK scores in government and denominational schools. SPSS output for the impact of teaching experience and school category on teachers' TK scores are detailed in Appendix J.

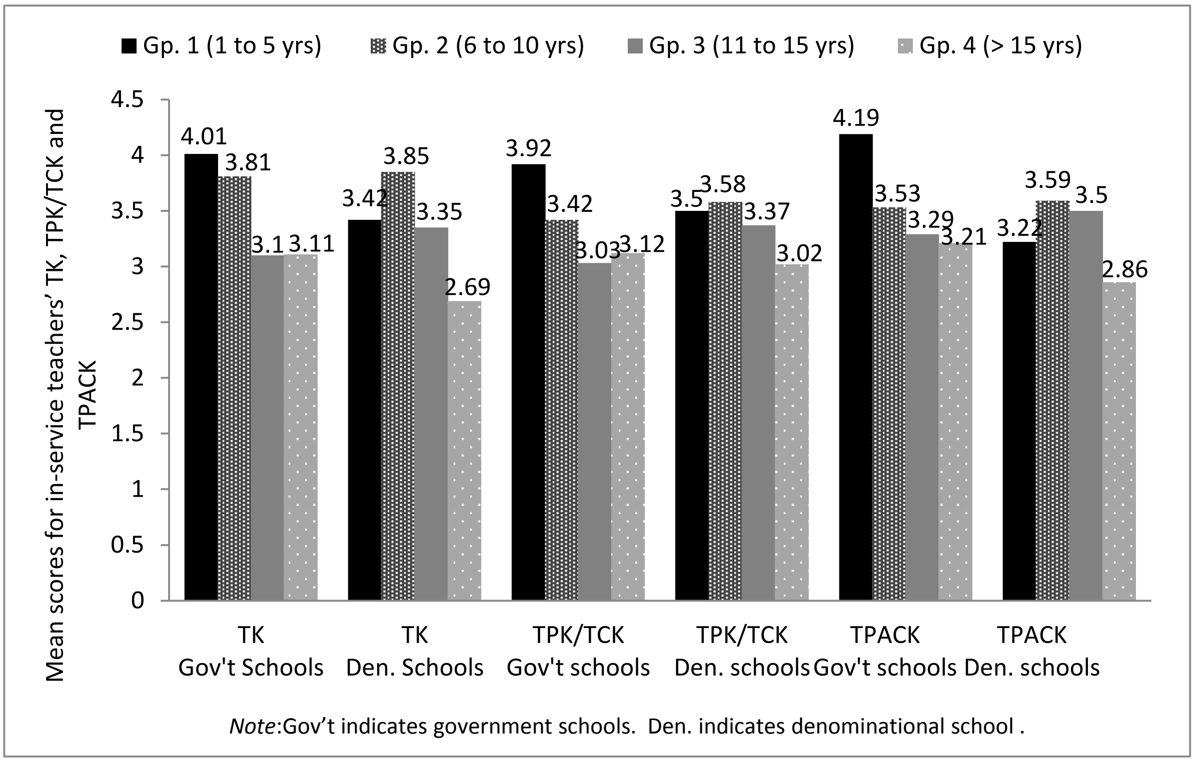


Figure 22. Impact of teaching experience and school category on teachers' TK, TPK/TCK, and TPACK mean scores

4.6.4 Teaching experience makes a difference in the classroom.

Figure 22 suggests teaching experience impacted upon teachers' TK, TPK/TCK, and TPACK scores. Examination of the overall results indicated Group 1 teachers who had less teaching experience obtained higher value of mean scores for TK, TPK/TCK, and TPACK than teachers who had more teaching experience from Group 2, Group 3 and Group 4. Group 2 teachers had higher mean scores for TK than Group 4 teachers. Comparing these results on the Likert scale for confidence to use ICT as specified by the items on the surveys, Group 1 and Group 2 teachers were within the range of moderately confident to above confident (M = 3.42 to M = 4.19). Group 3 and Group 4 teachers were within the range of partially confident to almost confident (*M* = 2.69 to *M* = 3.37). Interestingly, the results of the ANOVA for TK, TPK/TCK, and TPACK suggest teachers who had recently entered the teaching profession were more knowledgeable and confident to use ICT for the following: their students learning; their professional practice and pedagogy; and to support their students learning with ICT as compared as indicated by the items on the surveys.

4.7 Multivariate Analysis of Variance (MANOVA)

Research Question 4: *Do qualifications and instructional content areas impact upon in-service and pre-service teachers' TK, TPK/TCK, and TPACK scores respectively?*

In this study in-service teachers were those employed in secondary schools in Trinidad and Tobago. Pre-service teachers were candidates in their final year studying at two campuses at the University of Trinidad and Tobago to become qualified with an academic degree inclusive of teaching certification. Both cohorts were engaged in the instructional content areas of Maths, Science, and Humanities.

A two-way Multivariate Analysis of Variance (MANOVA) was conducted to investigate the impact of instructional content category and qualification on in-service and pre-service teachers' TK, TPK/TCK, and TPACK scores obtained from the surveys. An inspection of the results indicated a statistically significant difference for qualifications of the two cohorts of teachers F (3, 171) = 10.14, p = < .001; Wilk's Lambda = .85; partial eta squared (η^2) = .15. When the results of the dependent variables were considered separately for the Tests of Between-subjects effects, there was a statistically significant difference for qualification level on each dependent variable: for TK, F (1, 173) = 24.51, p = < .001, partial η^2 = .12; for TPK/TCK, F (1,

173) = 18.13, p = < .001, partial η^2 = .10; and for TPACK, F (1, 173) = 26.80, p < .001, partial η^2 = .13. The three sets of partial η^2 represented only 12% of the variance in TK, 10 % of the variance in TPK/TCK, 13% of the variance in TPACK, explained by instructional groups and qualification. Instructional content category did not reach statistical significance. Table 18 tabulates these findings.

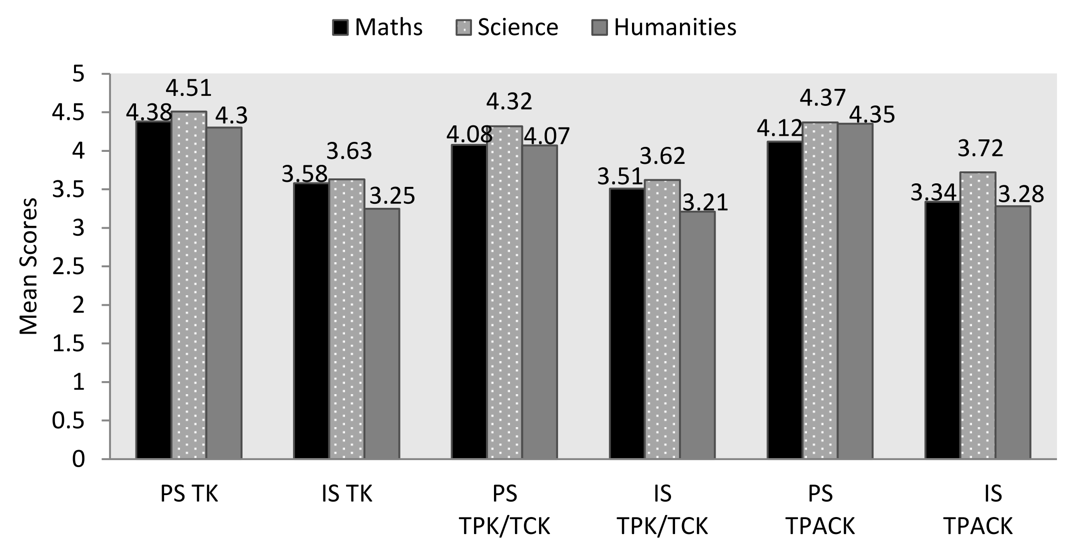
Table 18

Impact of Qualifications and Instructional Content Category on TK, TPK/TCK and TPACK scores.

Source (Dependent variable)		*df*	*F*	*Sig*	*Partial Eta Squared*
Qualifications (In-service and pre-service teachers)	TK	1, 173	24.51	.000[a]	.12
	TPK/TCK	1, 173	18.13	.000	.10
	TPACK	1, 173	26.80	.000	.13
Instructional content category (Maths, Science and Humanities)	TK	2, 173	1.27	.28 (NS)[b]	.02
	TPK/TCK	2, 173	1.78	.17 (NS)	.02
	TPACK	2, 173	1.39	.25 (NS)	.02

[a]Significant difference p<0.001. [b]NS = no significance between the three subject content areas

An inspection of the descriptive statistics in Figure 23 below indicated pre-service teachers obtained higher value of mean scores for TK, TPK/TCK, and TPACK than in-service teachers in the three instructional content areas, Mathematics, Science and Humanities. The results demonstrated pre-service teachers' mean scores for TPK/TCK were marginally higher in Mathematics and Science than in-service teachers. There was almost a 1 point difference in the value of mean scores for TK and TPACK in Humanities between pre-service and in-service teachers. The mean scores were taken from the descriptive statistics of the SPSS output of the MANOVA. Figure 23 captures in-service teachers and pre-service teachers' mean scores for TK, TPK/TCK and TPACK in Maths, Science and Humanities.



*Note.*IS represents in-service teachers; PS represents pre-service teachers.

Figure 23. Impact of instructional areas and qualifications on teachers' TK, TPK/TCK, and TPACK scores

4.7.1 Qualifications impacted on teachers' TK, TPK/TCK, and TPACK scores.

The results from the analysis of the MANOVA indicated qualifications impacted upon teachers' TK, TPK/TCK, and TPACK scores. Instructional content areas of Mathematics, Science, and Humanities did not impact on the scores. Examination of the descriptive statistics of the MANOVA suggested pre-service teachers were more knowledgeable to utilise technological knowledge, technological pedagogical knowledge/technological content knowledge, and technological pedagogical content knowledge in Mathematics, Science and Humanities as compared to in-service teachers. What was surprising, although 14% of the in-service teachers were qualified with a Master degree (as indicated by the demographic data) the entire cohort of in-service teachers' TK, TPK/TCK, and TPACK mean scores for the three instructional content areas were lower than the pre-service teachers' TK, TPK/TCK, and TPACK mean scores.

4.8 Factor Structures of Teacher Surveys

Research Question 5: *What are the factor structures of the teacher surveys*?

The TK survey and the TPACK survey were utilised in this study. The TK survey comprised the TK scale which investigated teachers' confidence to use 12 ICT devices for teaching and students' learning. The TPACK survey consisted of the TPK/TCK scale and the TPACK scale. Each consisted of 24 items. The TPK/TCK scale probed teachers' confidence to use ICT for their professional practice and pedagogy. The TPACK scale probed teachers' confidence to use ICT to support student learning with ICT. Exploratory factor analysis was performed separately on each scale to investigate its factor structure.

Principal Component Analysis (PCA) and Varimax with Kaiser Normalization as the rotation method were conducted. Inspection of the correlation matrix of the SPSS output, revealed there were many coefficients of .3 and above. An examination of the results of PCA indicated there were two sets of eigenvalues greater than 1 for each explaining 60.66% and 10.33% of the variance for TK; 66% and 5.29% for TPK/TCK; and 70.51% and 4.57% for TPACK. An inspection of the scree-plots in Appendix H indicated a clear break after the first factor for each of the three scales. Therefore, parallel analysis (Horn, 1965; Pallant, 2013) was performed to confirm the number of factors. Only one factor with eigenvalues more than the corresponding criterion values for a randomly generated data matrix of the same size (for example, 24 items for TPK/TCK x 226) was obtained. Once the factors were identified, each was confirmed via Maximum Likelihood extraction with Oblimin rotation. Items for TK, TPK/TCK and TPACK loaded separately on single factors at .4 or higher when they were constrained to do so. Hence the single-factor solution was accepted for each scale with the common thread of confidence to use ICT. Additionally, the reliability of each scale was computed using SPSS software. Cronbach’s Coefficient alpha values for TK = .94, TPK/TCK = .98 and TPACK = .98 were obtained. According to George and Mallery (2003), these values were excellent and indicated each measure on the survey had excellent internal consistency.

4.8.1 Factor loadings for TK.

The one-factor solution for TK explained a total of 60.66% of the variance. The factor was labelled: "confidence to use ICT devices." The loadings ranged from .82 to .63 with the highest for:

- Internal software.
- External software.
- Word Processing.

Table 19 presents the factor loadings for the 12 TK items and Cronbach's reliability coefficient.

Table 19

Factor Loadings for the TK survey

How confident are you to use the following ICT devices for your teaching and student learning?	Factor (Confidence to use ICT devices)
Internal software	.82
External software packages	.81
Word processing	.80
Multimedia devices	.80
Digital video for production and editing	.79
Spread sheet	.79
Databases	.79
Computer	.79
Digital camera/document camera	.77
Webpage design	.74
World Wide Web	.73
Interactive whiteboard	.63

Note. (N=226*)* Cronbach's Reliability Coefficient = .94

4.8.2 Factor loadings for TPK/TCK.

The one-factor solution labelled "professional practice and pedagogy supporting teaching" for TPK/TCK explained a total of 65.95% of the variance. The loadings ranged from .88 to 72 in descending order. The following items had strong loadings:

- Evaluate how ICT use has helped to achieve specific subject area goals.
- Use a range of ICT resources and devices for professional purposes.
- Demonstrate how ICT can be used to support literacy learning.

Table 20 presents the factor loadings for the 24 TPK/TCK items and Cronbach's reliability coefficient.

Table 20

Factor Loadings for TPK/TCK Surveys

How confident are you to use ICT to do the following?	Factor (Professional Practice and Pedagogy)
Evaluate how ICT use has helped to achieve specific subject area goals.	.88
Use a range of ICT resources and devices for professional purposes.	.87
Demonstrate how ICT can be used to support literacy learning.	.86
Design ICT activities that enable students to become active participants in their own learning.	.85
Identify personal and professional learning goals in relation to using ICT.	.84
Use ICT to engage with colleagues to improve professional practice.	.84
Use ICT to collaborate for professional purposes, such as online professional communities.	.84
Be aware of digital citizenship to promote student demonstration of rights and responsibilities in using digital resources and tools.	.84
Select and organize digital content and resources.	.83
Demonstrate an understanding of safe, legal and ethical use of digital information and technologies.	.83
Select and use a variety of digital media (e.g. interactive whiteboard, computer) and formats (excel and power point) to communicate information.	.82
Reflect on relevant ICT research to inform professional practice.	.82
Use ICT and teaching strategies that are responsive to students' learning styles.	.82
Use ICT and teaching strategies to support students from disadvantage backgrounds.	.81
Use ICT and teaching strategies to plan individualized learning activities for students.	.81

How confident are you to use ICT to do the following?	Factor (Professional Practice and Pedagogy)
Manage challenging student behaviour by encouraging the responsible use of ICT.	.80
Demonstrate how ICT can be used to support numeracy learning.	.79
Design lesson plans and assessments that incorporate ICT use by students.	.78
Use ICT to teach your specific subject/s in creative ways.	.78
Use ICT and teaching strategies that are responsive to students' diverse backgrounds.	.77
Engage parents and families in their child's schooling through ICT.	.76
Use ICT to access, record, manage, and analyse student record data.	.72
Use ICT for reporting purposes, such as reporting to parents/carers.	.75
Demonstrate knowledge of a range of ICT to engage students.	.74

Note.(N=226*)* Cronbach's reliability coefficient = .98

4.8.3 Factor loadings for TPACK.

The one-factor solution for TPACK explained a total of 70.51% of the variance. This factor was labelled: "support for students' learning with ICT". The loadings ranged from .89 to .81 in descending order. The following items had strong loadings on the one-factor solution for TPACK:

- To facilitate the integration of curriculum areas to construct multidisciplinary knowledge
- To acquire awareness of the global implications of ICT-based technologies on society.
- To critically evaluate their own and society's values.
- To develop understanding of the world.

Table 21 presents the factor loadings for the 24 TPACK items and Cronbach's reliability coefficient.

Table 21

Factor Loadings for the TPACK Survey.

How confident are you to use ICT to support your students' use of ICT in the following?	Support for student learning with ICT
To facilitate the integration of curriculum areas to construct multidisciplinary knowledge.	.88
To acquire awareness of the global implications of ICT-based technologies on society.	.88
To critically evaluate their own and society's values.	.88
To develop understanding of the world.	.87
To plan and/or manage assigned curriculum projects.	.87
To synthesize their knowledge.	.86
To actively construct their own knowledge in collaboration with their peers and others.	.86
To undertake formative and/or summative assessment.	.86
To critically interpret and evaluate the worth of ICT-based content for specific subject area/s.	.86
To engage in sustained involvement with curriculum activities.	.86
To engage in activities of the learning process.	.86
To understand and participate in the changing knowledge economy.	.86
To acquire the knowledge, skills, abilities and attitudes to deal with on-going technological change.	.85
To develop rich understanding about a topic of interest relevant to the curriculum area/s being studied.	.85
To demonstrate what they have learned.	.85
To gain intercultural understanding.	.85
To develop competencies in your subject area/s.	.84
To actively construct knowledge that integrates curriculum areas.	.84
To analyse their knowledge.	.84
To gather information and communicate with a known audience.	.83
To integrate different digital media (internet, video, digital camera) to create appropriate projects.	.83
To engage in independent learning through access to education at a time, place and pace of their own choosing.	.82
To communicate with others locally and globally.	.81
To provide motivation for curriculum tasks.	.85

Note. (*N* = 226), Cronbach's reliability coefficient = .98

4.9 Comparison of TPACK Scores on an International Level

Research Question 6. *What is the comparison of pre-service teachers' TPACK scores from Australia and Trinidad and Tobago?*

Trinidad and Tobago pre-service teachers ($N = 53$) in this study responded to the TPACK survey in 2013. Prior to this, Australian pre-service teachers ($N = 486$) from one regional university had participated in the same survey in 2011. At that time the TTF TPACK survey consisted of 20 items. Therefore the responses for the four items which were later added when the pre-service teachers in Trinidad and Tobago had participated in the survey, were not included for Research Question 6.

Standard scores (*Z* scores) were computed to compare the mean scores of Trinidad and Tobago and Australian pre-service teachers' confidence to use ICT to support their student use of ICT as specified on the 20 items of the TPACK survey. Inspection of result for individual item revealed a statistically significant difference ($p \leq .05$) in six items. The Australian pre-service teachers' mean scores was higher in five (25%) of the items whereas Trinidad and Tobago pre-service teachers had a higher mean score in one item. Australian pre-service teachers were more confident to use ICT to support student use of ICT in the following areas where $M_{A\ pre\text{-}service}$ represents mean score for Australian pre-service teachers and $M_{TT\ pre\text{-}service}$ represents mean scores for Trinidad and Tobago pre-service teachers:

- Provide motivation for curriculum tasks ($M_{A\ pre\text{-}service} = 4.23$, $M_{TT\ pre\text{-}service} = 3.83$).
- Synthesise students' knowledge ($M_{A\ pre\text{-}service} = 3.93$, $M_{TT\ pre\text{-}service} = 3.60$).

- Demonstrate what students have learned ($M_{A\ pre\text{-}service}$ = 4.31, $M_{TT\ pre\text{-}service}$ = 3.95).
- Engage in sustained involvement with curriculum activities ($M_{A\ pre\text{-}service}$ = 4.17, $M_{TT\ pre\text{-}service}$ = 3.67).
- Engage in independent learning through access to education at a time, place and pace of their own choosing ($M_{A\ pre\text{-}service}$ = 4.26, $M_{TT\ pre\text{-}service}$ = 3.86).

Trinidad and Tobago pre-service teachers were more confident to use ICT to support their student use of ICT in the following area.

- Support elements of the learning process ($M_{A\ pre\text{-}service}$ = 4.20, $M_{TT\ pre\text{-}service}$ = 4.50).

The results also indicated there was generally a high level of consistency for confidence to use ICT and support students' use of ICT for both cohorts in 14 (70%) of the items of the TPACK survey. There was no significant difference for the mean scores for these items. Some of the items were:

- Develop functional competencies in a specified curriculum area ($M_{A\ pre\text{-}service}$ = 3.99, $M_{TT\ pre\text{-}service}$ = 4.12).
- Gain intercultural understanding ($M_{A\ pre\text{-}service}$ = 4.01, $M_{TT\ pre\text{-}service}$ = 3.76).
- Develop understanding of the world ($M_{A\ pre\text{-}service}$ = 4.36, $M_{TT\ pre\text{-}service}$ = 4.27).
- Plan and manage curriculum project ($M_{A\ pre\text{-}service}$ = 4.20, $M_{TT\ pre\text{-}service}$ = 3.88).

- Communicate with others locally and globally ($M_{A\ pre\text{-}service}$ = 4.50, $M_{TT\ pre\text{-}service}$ = 4.41).

Table 22 presents the mean scores for the TPACK items together with the values for *Z* and estimates of the probability ($p \leq .05$) for both cohorts of pre-service teachers.

Table 22

Comparison of Teachers' TPACK Scores in Australia and Trinidad and Tobago

How confident are you that you can use ICT to support students' use of ICT to …	Australian Teachers (*N* = 486)		[a]T&T Teachers (*N* = 53)			
	M	*SD*	*M*	*SD*	*Z*	*p*
Provide motivation for curriculum tasks.	4.23	1.25	3.83	1.20	2.22	[b]0.03*
Develop functional competencies in a specified curriculum area.	3.99	1.31	4.12	1.18	0.80	0.42
Actively construct knowledge that integrates curriculum areas.	4.07	1.32	4.03	1.20	-0.24	0.80
Actively construct their own knowledge in collaboration with their peers and others.	4.07	1.28	4.10	1.34	0.16	0.87
Synthesise their knowledge.	3.93	1.32	3.60	1.27	-1.89	[b]0.05*
Demonstrate what they have learned.	4.31	1.28	3.95	1.28	-2.05	[b]0.04*
Acquire the knowledge, skills, abilities and attitudes to deal with on-going technological change.	4.24	1.35	4.48	1.33	1.31	0.19
Integrate different media to create appropriate products.	4.00	1.38	3.83	1.17	-1.06	0.29
Develop deep understanding about a topic of interest relevant to the curriculum area/s being studied.	4.17	1.30	4.11	1.09	-0.40	0.69
Support elements of the learning process.	4.20	1.27	4.50	1.13	1.93	[b]0.05*
Develop understanding of the world.	4.36	1.22	4.27	1.18	-0.56	0.58
Plan and/or manage curriculum projects.	4.20	1.32	3.88	1.24	1.88	0.06
Engage in sustained involvement with curriculum activities.	4.17	1.33	3.67	1.19	-3.06	[b]0.02*
Undertake formative and/or summative assessment.	4.16	1.37	4.29	.86	1.10	0.27
Engage in independent learning through access to education at a time, place and pace of their own choosing.	4.26	1.36	3.86	1.30	-2.24	[b]0.03*
Gain intercultural understanding.	4.03	1.32	4.26	1.04	1.61	0.11
Acquire awareness of the global implications of ICT-based technologies on society.	3.93	1.34	4.02	1.20	0.55	0.58

How confident are you that can to use ICT to support students' use of ICT to …	*Australian Teachers (N = 486)*		*[a]T&T Teachers (N = 53)*			
	M	*SD*	*M*	*SD*	*Z*	*p*
Communicate with others locally and globally.	4.50	1.27	4.41	1.33	-0.50	0.62
Understand and participate in the changing knowledge economy.	4.05	1.35	3.82	1.30	-1.28	0.20
Critically evaluate their own and society's values.	4.01	1.33	3.76	1.25	-1.46	0.15

[a]Trinidad and Tobago. [b]Significant at .05

4.9.1 Summary of quantitative analyses.

This section of the results has addressed the first six research questions which are quantitatively analysed, as outlined at the beginning of this chapter. The relationship, factor structure, and reliability of TK, TPK/TCK, and TPACK scores were explored. There was a strong positive linear relationship between each pair of variables. The highest was between TPK/TCK and TPACK (r = .88), followed by TK and TPK/TCK (r = .79) and then TK and TPACK (r = .77). The items of each scale had strong loadings on the one-factor solution for each set of scores.

Independent-samples *t*-tests indicated pre-service teachers were more confident than in-service teachers to use ICT for their pedagogical practices and to support students' learning with ICT. Some unexpected results were also obtained from the ANOVA and MANOVA. Pre-service teachers and teachers who had recently entered the teaching service were more confident in the application of ICT for teaching and student learning as compared to those who were employed longer in secondary schools. The results also revealed teaching experience and qualifications impacted on teachers' TK, TPK/TCK and TPACK scores. School category and instructional content areas had little impact. According to the results of the *Z* test, there was generally a high level of consistency for confidence to use ICT to support students' use of ICT between Australian and Trinidad and Tobago teachers on the TPACK survey.

4.10 Qualitative Analyses

To continue the investigation of teachers' ICT integration and the eConnect and Learn program, a series of one-on-one interviews were conducted. The participants were: in-service teachers (n = 21) from 10 secondary schools; pre-service teachers from two campuses of the University of Trinidad and Tobago (n = 15); ICT technicians employed in secondary schools (n = 5); school supervisors from three out of the eight educational districts (n = 3); and the Director of the eConnect and Learn program (n =1). Detailed analyses of their interview data provided a broader, deeper, and insightful understanding of various aspects for the quantitative results as well as for Research Questions 7 and 8. In addition the responses informed perceptions of the impact of the eConnect and Learn program.

4.11 Reliability of the Coding process

A combination of a modified form of three coding strategies, open, axial, and selective of grounded theory and six steps of thematic analysis (Braun & Clarke, 2006) supported by NVIVO software were used to analyse the data and identify themes from the interview sessions. The coding strategies of grounded theory were discussed in detail in Chapter 3 from page 91 to 94. The modified form of the six steps of thematic analysis will now be described. Firstly, transcribed data item of each interviewee was actively read to explore, interpret and capture its meaning. Patterns were sought and an initial list of potential themes to be used as parent nodes was generated. The transcripts were then imported into NVIVO. Secondly, the coding and analytical process began.

Each data item was reread and data extracts with similar and different patterns were collated in separate nodes under the appropriate parent node. Research Questions 7 and 8 guided the initial node structures and themes. Annotations and memos were recorded for subsequent references. Thirdly, after the initial coding process, the nodes with coded data from the dataset were sorted to ensure they were placed under the most appropriate potential themes. Nodes were merged or new nodes were created as new patterns, concepts, and themes or sub-themes were identified. Fourthly individual themes were reviewed to ensure their validity in relation to the dataset. All the collated extracts for each theme were read and re-read to ensure they form a coherent pattern. Coded extracts which did not fit were sorted in a node under a more appropriate theme. The fifth phase confirms the name of each theme to convey the meaning of the data extract from the dataset. The entire dataset was reread to reconfirm the validity of the themes. Also if important data were left out, they were then coded and placed under the relevant theme. Finally themes were refined and further defined to analyse the data within them. This process supported accurate responses to Research Questions 7 and 8 which were used as a guide for the presentation in this section. Four overarching themes were identified:

- Teacher support
- Challenges of the eConnect and Learn program
- Pedagogical practices with computers and related devices.
- Implications for the future of the eConnect and Learn program.

Common themes, constructed categories, and the most common words used in the interview (word cloud) are detailed in Appendix K.

The following section is guided by Research Questions 7 and 8 under the four overarching themes which were developed from the coding and categorising process. Each theme described the participants' views and perceptions of the eConnect and Learn program during the interview sessions. Examples of their responses are provided.

Research Question 7: *Can Moersch's (2010) Levels of Teaching Innovation be used to review and interpret teachers' interview data relating to pedagogical practices with computers and related devices?*

Research Question 7 was completed in two phases. Firstly, participants' interview data were analysed to present an understanding of their views and perceptions of the eConnect and Learn program. Secondly, teachers' interview data were reviewed and interpreted using Moersch's (2010) Levels of Teaching Innovation. The following over-arching themes were utilised: teacher support; challenges of the eConnect and Learn program; pedagogical practices with computers and related devices; and implications for the future of the eConnect and Learn program.

4.12 Common Themes and Categories

4.12.1 Teacher support.

Participants were asked to describe the perception of the support provided by their administrators and the Ministry of Education to facilitate the integration of ICT for teaching and learning. An analysis of their responses was coded under the overarching theme, teacher support, which was collapsed into four categories: infrastructure, resources, professional development, and collaboration. These categories were identified in the coding process as important factors in the learning environment to facilitate the successful integration of the eConnect and Learn program.

Infrastructure.

An inspection of the analysis of the interview data revealed internet connection, electrical installation, security, and technical assistance were important components for enhancing the infrastructure of the eConnect and Learn program. A number of infrastructural challenges were encountered in the introduction of the program even though the Ministry of Education (MOE), ICT technicians, and principals sought solutions in different ways. Each school had internet connectivity and WiFi access in the library, the two computer labs, the school's office, and in a few classrooms. The internet connection did not have the capacity to enable the entire school population (approximately 500 to 850 students) to simultaneously access the WiFi bandwidth. Consequently a convenient location, such as an open hall or selected classrooms of each school was provided with an open WiFi access for students to use the World Wide Web for research and other related activities on a daily basis. Although this was a positive arrangement, most teachers articulated it was inconvenient to move their classes to the designated location because of time constraint. The teaching period lasted 35 to 40 minutes and other teachers also needed access to the area.

The following excerpts identified challenges encountered with the physical infrastructure of the classrooms in terms of internet and electrical outlets. Alpha numeric codes were given for each participant. The number at the end indicated the line number of the transcript.

IS9CD, 34: If for instance all of form one, two, three and four all have their laptops on at the same time, there is a major access problem where we could crash the system. When there is an IT class going on the system gets very slow.

IS11CG, 61: All children come with their laptops, but some are not charged properly, we don't have sufficient power points in the room for them. The infrastructure is a problem.

Resources.

Although teachers were not provided with personalized laptop computers, each department in participating schools had access to five computers and at least two mobile digital projectors. In addition to these facilities, the staff had access to the school's digital cameras, document cameras, scanners, printers and photocopying machines but the school's policy and culture inhibited the independent use of these resources. Teachers had to apply at least a week in advance to the Head of their Department for permission to utilize any of these resources. A "chunk" of teaching time was reduced by the time the equipment was set up to be used in the classroom. Teachers who did not have a specialised room for their specific subject area, such as English Language, were also at a disadvantage if the equipment had to be moved from class to class. Another challenge that widened the gap to use the affordances of the eConnect and Learn program was an absence of access to educational software. The following extracts from the interview emphasised some of these concerns:

IS4CG, 162: You are switching periods every hour, half an hour, 45 minutes, so how can I use this device, the laptop, to its full potential, when I do IT, when I switch to geography, history, Maths.

IS7FD, 45: If …I could put my hands on software I can't use that on the computers, because we have to go through some paperwork and apply for it to be used.

Application to use these resources frustrated teachers and prevented them from embracing the uptake of available resources. They perceived a sense of mistrust and felt a lot of their planning time was wasted with the school's policy to borrow resources and to give accountability for their use. To cope with the situation, 15% of the teachers bought their own computers, scanners, and digital projectors for easier accessibility to essential resources. They did not depend on the support of their administrators, Head of Department, or Ministry of Education in this respect.

Professional development.

Professional development to enhance pedagogical content knowledge for ICT integration was initially organized during the vacation period by the Ministry of Education. Many teachers were unable to attend because the timing was inconvenient to them. After the first year of the program, principals attempted to arrange similar internal workshops. These were conducted by their Information Technology teachers and the ICT technicians. Teachers perceived the combination of these two cohorts enabled the delivery of technological knowledge and little technological pedagogical content knowledge. According to the interview data, time allocation to organise these workshops varied in schools. Table 23 presents 21 responses related to the arrangement of workshops in the 11 secondary schools which participated in the interview sessions.

Table 23

Teachers' Responses to the Frequency of Workshops

Arrangement of ICT workshop	Responses
Five hours per day for five days in 2010 by the Ministry of Education.	10 (48%)
For one hour by the IT teachers once per semester.	5 (19%)
Once per academic year for one hour.	2 (10%)
Once or twice a month for one hour in each curriculum department.	2 (10%)
Teachers were not aware of any workshops being held in schools.	2 (15%)

Note. (*N*=21)

Data represented in Table 23 were also confirmed by the following participant:

IS20MD, 88: Initially, when the drive was for computers in 2010, there were lots of workshops. They started with regular workshops during the day and then it spiralled down on evenings, Saturdays or during the holidays.

One of the school supervisors reported that although the Ministry of Education provided professional education for teaching and learning with computers and other resources, the practice was not there, and concluded:

SS3V, 9: Change is difficult and not e-confident and e-mature to be glad to use technology.

Although there were inconsistencies in the organisation and attendance of workshops, 20% of the teachers articulated they were introduced to Microsoft Photo Story, eBeam, and Google Docs. Websites such as Edmodo, WebQuest, and Pennacool were explored. Additionally, 14% of the teachers independently learned to use Web 2.0 technologies, accessed online training programs, and utilise software for their pedagogical practices and eLearning using their personal computers.

Collaboration.

Formal and informal collaborative planning for pedagogical practices to enhance the infusion of the eConnect and Learn program varied in secondary schools. Time allocated for formal collaboration lasted for about an hour and varied from once per week, to once per month, to just once per semester in five schools. In three schools, teachers (30%) expressed there was no fixed time for collaboration in their teaching schedule. The pedagogical practices and eLearning, which worked well for teachers, were shared informally with each other during recess or lunch periods. Those who were given specific time for collaboration were often disappointed. The following explains the disappointment:

IS19CG, 144: That meeting is just for the administration to hand down information to the teachers about what is required and what they need to do to fulfil the requirements of what the Ministry wants. They will come and tell you that we have this to do, we have that to do.

Teachers (19%) from two schools reported they did not discuss ICT integration formally or informally due to time constraints. They were too involved in extra-curricular activities or were pressured to complete the syllabus. One of the main findings indicated the time allotted for teachers personal daily pedagogical planning (about 40 minutes) or collaboration with others was often affected by supervision of students whose teachers were absent. This is summarised by one participant:

IS19CG, 146: Yes we normally have to supervise. If you go, you would see a supervision roster done for today-so when teachers are free to do their planning they have to supervise classes.

4.12.2 Challenges of the eConnect and Learn program.

The theme challenges of the eConnect and Learn program was collapsed into two categories: technical support and classroom management. These categories were identified in the coding process as important factors in the learning environment for the uptake of the eConnect and Learn program. Examples of teachers' responses extracted from the interview data are also provided.

Technical support.

Teachers perceived technical support was inadequate. A hot-line service was available only during the one year warranty period after the initial distribution of the laptop computers provided by the eConnect and Learn program. ICT technicians and the Director of the program reported an average of 10 to 30 damaged computers was repaired on a monthly basis. Arrangements for security of laptop computers in the classrooms were not supported by the Ministry of Education. Since there was no replacement for computers when they were under repair, students were unable to engage in research activities and to complete assignments in a timely manner. To make matters worse, only one ICT technician was assigned to each secondary school. His/her portfolio extended to oversee the computer labs in at least five primary schools. School supervisors who were in charge of devising an ICT plan reported they acknowledged difficulties teachers encountered, such as warranty issue, connectivity, repair and replacement.

Classroom management.

Classroom management became more of a problem where students used their laptop computers for gaming and sending messages to their peers during curriculum activities. As a result of this, 50% of teachers did not permit students to bring their computers to classes. Tasks, such as assignment and research were assigned for students to complete at home. Access to the internet at home was limited. Some parents did not install internet connectivity because they were afraid of unworthy content their child/children may access on the World Wide Web. These students had to access the internet to complete the given tasks in either their school's library or the public library where there was free internet services.

IS19CG, 11: They weren't supposed to download games on the computers but they did and still do. They come to school and play the games during class time, lunch time and break time. The computers are used for everything else but what it was designed to do, which is for learning using technology.

4.12.3 Pedagogical practices with computers and related devices.

The theme, pedagogy with computers and related devices was developed from four of the identified categories: ICT perception, confidence, TPACK, and pedagogical practices. These categories were central to explore and understand how teachers were integrating computers and related devices in their pedagogical practices for teaching and student learning.

ICT Perception.

Four layers of ICT perception were articulated when in-service (*n* = 21) and pre-service (*n* = 15) teachers were asked, "What comes to your mind when you hear the acronym ICT (Information and Communication Technologies)". This question was important to stimulate teachers to think about ICT tools, make association with their ICT training as well as their experiences in the application of ICT for pedagogical content practices. Analysis of the interview data revealed 17 responses were articulated from a mechanical perspective. This was termed "the what" in layer one. Examples given were devices, computers, videos, YouTube, email, and software. Responses which explained the purpose and use of ICT, for example, "to facilitate teaching and learning" and "communicating, stimulating, and generating interest" were classified as "the how" in layer two. Responses grouped in layer 3 described the application of ICT, for example, "to help students conceptualize topics easier and better in different subject areas." The responses grouped in layer four illustrated the synthesis of ICT, for example, "for integration of technology in content areas in specific disciplines." Although deeper explanation of the perception of ICT was provided in layers three and four, there were few responses. Overall teachers articulated what came to their mind when they heard the acronym ICT, which is indicative of their conceptualization of the term. Inspection of Table 24 demonstrates the responses provided for each layer.

Table 24

Teachers' Perception of ICT

Layer one: "The what."	Layer two, "The how" for specific uses.	Layer three: "The application"	Layer four :"The synthesis"
Devices: computers- laptops and desktop,	To facilitate teaching and/or student learning.	Teaching and learning in creative ways.	Productive teaching and learning.
videos, PowerPoint, projectors, interactive whiteboard,	For communicating/ enhancing / stimulating / generating interest in teaching and learning..	For simulation- to help students conceptualize topics easier and better in different subject areas.	For integration of technology in content areas in specific disciplines.
multimedia, Facebook' YouTube, email, software programs, twitter, social networks, iPads, notebooks.		Improve science teaching by using technology and pedagogical skills for different strategies.	It entails incorporating technology with social skills and science as well as its application to our everyday life.

Note. N = 36.

Confidence to use computers and related devices.

In-service and pre-service teachers were asked to rate their level of confidence in the use of computers and related devices for teaching and student learning on a scale from not confident to very confident. They were asked to think about their ICT knowledge, skills, and abilities in relation to their application of computers and related devices before responding to the question. A total of 36 responses were made. Confidence ranged from partially confident to very confident for in-service teachers and partially confident to confident for pre-service teachers. These responses are presented in Table 25.

Table 25

Teachers' Confidence to use ICT

How confident are you to integrate computers and related devices in your teaching and student learning?					
Teachers	Partially confident	Moderately confident	Confident	Very confident	Extremely confident
Pre-service teachers (n = 15)	3 (20%)	6 (40%)	6 (40%)	-	-
In-service teachers (*n* = 21)	5 (24%)	6 (29%)	7 (33%)	3 (14%)	-

Note. N=36.

Meaning of technological pedagogical content knowledge (TPACK).

Teachers' were asked to explain the meaning of technological pedagogical content knowledge (TPACK) and describe how the concept is implemented in their teaching and student learning. Responses of pre-service and in-service teachers are outlined in Table 26.

Table 26

Teachers' Responses for the Explanation of TPACK

Responses for the explanation of TPACK	Pre-service teachers (n = 15)	In-service teachers (n = 21)
Have not heard the term before.	9 (60%)	19 (90%)
Related to teaching and technology.	4 (26%)	2 (10%)
Integrating technology for pedagogical practices and learning.	1 (7%)	-
Incorporating technology with science.	1 (7%)	-

Note. N=36.

An examination of Table 26 indicated teachers were not aware of the meaning of TPACK. Brief interpretation of the term was described by the participants as: technology and teaching; integration of technology; and the incorporation of technology with science.

Pedagogy with computers and related devices.

From the evidence provided in Table 26, teachers were not knowledgeable of the term technological pedagogical content knowledge (TPACK). Therefore, the format of the question was changed and teachers were simply asked to describe their use of computers and related devices for their pedagogical practices and for dissemination of curriculum activities. The responses were important to determine how teachers were making use of the eConnect and Learn program after three years of its initial introduction in secondary schools. Furthermore, the responses were important to better understand and provide insights of teachers' ICT integration in their pedagogical content practices. Therefore only in-service teachers' responses were utilised in the analysis of the question. Pre-service teachers' responses were excluded because they were still studying at the University of Trinidad and Tobago. Therefore, they accessed the affordances of the eConnect and Learn program only during their teaching practicum (learning experience) which was arranged for three months over their four year undergraduate degree. Their responses were important for discussion in Chapter 5 to shed light of the results of the quantitative data.

The eight stages of the Levels of Teaching Innovation (Moersch, 2010) were selected to review and interpret in-service teachers' responses of their pedagogical practices with computers and related devices. Table 27 summarises the Levels of Teaching Innovation which were described in detail in Chapter 2 in Table 3 on page 52.

Table 27

Summary of Moersch's (2010) Levels of Teaching Innovation

LoTi Level	Description
Non-Use – Level 0	No integration of ICT.
Awareness Level 1	Instruction is didactic incorporating the simplistic form of educational technology to enhance lecture and classroom management by teachers.
Exploration Level 2	Teachers and students use computers and related devices for extension/enrichment/ reinforcement/ research.
Infusion Level 3	Teachers design instruction for students to develop higher order cognitive skills such as inductive, scientific and inquiry approach to complete teacher-directed tasks.
Integration- Mechanical Level 4A	Students engage in exploring real world issues. Teachers rely on pre-packaged materials and internal/ external software. Development of 21st Century skills begin.
Integration-Routine Level 4 B	Metacognitive, innovation, creativity and problem solving skills are further developed.
Expansion Level 5	Integration of complex digital tools for teaching and learning are utilised.
Refinement Level 6	TPACK based activities for students' individual needs and aspirations. Value beyond School is practised.

Table 28 presents in-service teachers' responses of their pedagogical practices with computers and related devices.

Table 28

Analysis of In-service Teachers' Pedagogical Practices with Computers and Related Devices

Levels of Teaching Innovation	Pedagogical practices	Description	*n* = 21	Responses per level
Non-Use Level 0	No use of computers	'Talk and chalk' only.	3 (14%)	3 (6%)
Awareness Level 1	PowerPoint	Teacher presented and explained concepts	8 (39%)	21 (43%)
	Videos and DVD	To provide motivation for curriculum activities.	6 (29%)	
	Computers	To design lesson plans, puzzles, worksheets, survey	3 (14%)	
	Document camera	To allow students to view diagrams and write notes	3 (14%)	
	Email	Emailed assignments to students	1 (5%)	
Exploration Level 2	Websites	For research and extension activities	4 (19%)	9 (18%)
	Videos	Ask students to download videos at home for reinforcing concepts done during class sessions	3 (14%)	
	Puzzles , tutorials and worksheets	For enrichment and reinforcement of concepts	2 (10%)	
Infusion Level 3	Video and PowerPoint	Students made and presented PowerPoint and videos on given topics.	3 (14%)	8 (16%)
	Spread sheet	Completed graphs, matrices, charts, map work	1 (5%)	
	Word Processing	Students researched, created, edited, and printed document on a given project.	1 (5%)	
	Hyperlinks	Teachers directed students to use hyperlinks.	1 (5%)	
	Simulation software	Teachers instructed students to create 3D models	1 (5%)	
	WordPress	Used for enhancing creative writing	1 (5%)	

Levels of Teaching Innovation	Pedagogical practices	Description	n = 21	Responses per level
Integration-Mechanical Level 4A	Websites	Teachers accessed Pennacool.com and Sanako Lab 100 for sourcing teaching materials.	2 (10%)	5 (10%)
	Video	Students made a video in geography and have it available to their classmates.	1 (5%)	
	External software	Accessed pre-packaged materials from Ministry of Tourism, Culture, Family Affair	1 (5%)	
	Application	Critical analysis and collaboration of dance movements for improvement in Visual Arts	1 (5%)	
Integration-Routine Level 4B	Innovation and Creativity	Designed advertisement for media company	1(5%)	1 (2%)
Expansion Level 5	Webinars	Online professional development	1 (5%)	1 (2%)
Refinement Level 6	Blogs	Blogging with a teacher in Japan. Blogging with students to improve literacy	1 (5%)	1 (2%)

Note. (*n* = 21).

An examination of Table 28 indicated 6% of teachers' responses implemented the 'talk and chalk' method (Newlin & Wang, 2002) in the delivery of instructional content knowledge. The highest number of responses, 43%, was interpreted at the Awareness level (Level 1) where teachers were most confident to use the simplistic form of educational technology to embellish teacher-directed instructions. The number of teachers' responses reduced to 18% at the Exploration Level; 16% at the Infusion level; and 10 % at the Integration Mechanical level. There were less responses as Moersch's (2010) Levels of Teaching Innovation became more complex for the integration of ICT with pedagogical content practices. There was one response each for the Integration Routine, Expansion, and Refinement levels respectively.

Blogging and webinars reflected value beyond the school in the Refinement level where teachers in the same profession communicated online with others. A blog was set up for students in one class to help improve their literacy skills.

The findings in Table 28 indicated that the application of the Levels of Teaching Innovation was relevant to review and interpret teachers' pedagogical practices with computers and related devices. The results suggested the eConnect and Learn program partially diffused at the micro level in the classrooms. This finding was further strengthened by the analysis of data discussed under the three themes: teacher support; challenges of the program; and pedagogical practices with computers and related devices.

4.12 4 Implications for the future of the eConnect and Learn program

Research Question 8: *What implications are there for the future of the eConnect and Learn program?*

Participants were asked to describe the implications for the future of the eConnect and Learn program. The responses were analysed under the overarching theme: Implication for the future of the eConnect and Learn program. This theme was collapsed in five categories: enhancing professional education, students' use of laptop computers, resources, and infrastructure, and future improvement for the implementation of the eConnect and Learn program. These categories were identified based on the concerns made by the respondents during the interview sessions. Examples of participants' responses were provided to support the analysis of the interview data.

Enhancing professional education.

Teachers (69%) perceived that they required appropriate knowledge to integrate the eConnect and Learn program in more productive ways for teaching and learning. Neither did they want to remain in their comfort zone using the same pedagogical strategies nor did they want to appear incompetent in the application of ICT for their students who were considered to be ‘computer savvy’. There was concern that ICT technicians and Information Technology teachers were given more opportunities to attend ICT seminars, workshops, and professional development than the other members of the teaching staff. Teachers were interested to change this norm so that they can become more educated in ICT integration. In addition, school supervisors and the Director of the eConnect and Learn program articulated they wanted teachers to present instruction in a more stimulating, innovative, and defining mode to students. The following proposals were expressed by participants to achieve these goals:

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- Ongoing structured professional development should be organized by principals and school supervisors at a time and place convenient to all members of staff.
- Workshops and seminars should be delivered by knowledgeable people who are familiar with new and emerging educational technologies. The agenda must include ways to integrate technological knowledge with curriculum content and pedagogical strategies.
- National and international conferences should be brought to the attention of teachers. Time and reimbursement should be set aside to make these learning experiences possible.

The following excerpts supported the proposals:

IS13FD, 92: A lot of teachers learn on their own and ... learn from their students so I think something more structured should be offered to teachers on an ongoing basis to train them and try at least to give them those skills.

IS15FD, 46: Not only training to one or two teachers in each school but to all teachers ....there are lots of older teachers who are not IT competent. Of course all teachers like to learn new things, and there are always new things coming out.

IS10CD, 184: And maybe attend conferences, not only locally but internationally. We have been to local conferences and curriculum officers don't know what is going on … and send teachers abroad for training as well …

Students' use of laptop computers and dependency on amenities.

Teachers observed students were moving from class to class with their heavy laptop computers. They also observed students were using the laptop computers provided by the eConnect program to listen to music and to play games. Consequently, teachers perceived this as limited socialisation with peers as well as inattentiveness and inadequate engagement in curriculum activities. Teachers were also concerned that students were becoming too dependent upon amenities provided freely by the government. The following proposals were made to alleviate these problems.

- The culture of providing free books, lunches, transportation, education and laptop computers should be changed so that students should work and be rewarded to earn and appreciate these amenities.
- Alternative devices, such as a Kindle or simply a tablet should be provided to students instead of the heavy laptop computers,
- Students should be educated to use Microsoft Office and access relevant search engines to discover concepts related to instructional content areas. Engagement in these activities have the potential to make students become more proficient to use the affordances of the eConnect and Learn program. They should be given opportunities to present projects and as a result collaboration and more socialisation could be fostered among students.
- Time should be allotted for students to practise and present what they learned. In addition, students from primary schools should be educated to use computers and related programs before transitioning to secondary schools.

The following excerpts supported these suggestions:

IS15FD, 42: I would recommend a program where the students should qualify to get a laptop computer. Let them earn the laptop … they would learn the actual value of the laptop rather than bring it and play games or put it in a corner. They don’t appreciate it.

IS4CG, 164: We can move beyond the laptops, because laptops today are bulky items to carry about … Amazon has the Kindle, a very small device, very powerful, you can have all the texts electronically converted instead of a bag full of books … or the tablet in an e-Reader form.

PS3V, 32: Teach them how it could be used for research purposes, and … the Office applications too. Because a lot of projects they can start to do on using Office programs … you can use a search engine for some of the project

PS8C, 54: And not only how to use it but let them be able to show, present what they learn in that way, because they are underutilising the laptop …

Resources.

Teachers perceived school's policy affected their independent use and access to essential resources. Each teacher had to apply for use of digital resources, social networks and external software to be used in the classroom. Only 10% of the teachers indicated they were permitted to borrow the laptop computers from their department to prepare work at home for their students. In addition, all teachers had to submit materials for photocopying to the administration at least a week in advance. This policy affected presentation of current events which were unpredictable and could occur at any time, such as a political events or new discoveries. Providing copies of recent news to students was often delayed. The following proposals were made to alleviate these problems.

- Computers and related devices from each department should be free for use without having to make an application to access them.
- Subsidies should be provided for teachers to purchase their own computers and related devices.

- A workstation with a photocopying machine and other digital devices should be made available for teachers. Each teacher should be allowed a fixed number of photocopies per day.

The following excerpts substantiated these suggestions:

IS10CD, 184: Subsidies should be given to teachers to purchase the necessary resources that they need.

IS11CG, 49: Printer and photocopier, there are issues … in most schools. I am a social studies teacher and I am coming to school and there is something on the newspaper that could work well. Now because that is not given to them two or three days in advance, you can't get copies.

Infrastructure.

Poor infrastructure and internet accessibility affected teaching and learning. Teachers wanted alternative measures to be put in place to ensure at least one room was completed with full infrastructure: electrical outlets, internet with WiFi accessibility, an interactive whiteboard, an LCD projector and a printer. Access to the room should be organized for use by members of staff and their students on a regular basis. Another proposal focussed on the installation of solar panels to be installed in all schools. This has the potential to reduce the cost of electricity. The money saved can be channelled for the provision of additional electrical outlets in the classroom as well as to purchase educational technology software and hardware. The following excerpt substantiated one of the proposals.

IS5MD, 144: They will want to look at alternative technology as well, such as, solar panels … so that it can take off some of the school's current load and the country's network of electricity as well.

Future improvement for the implementation of the eConnect and Learn Program.

Participants acknowledged there was an absence of a feasibility study and a pilot project before the distribution of the laptop computers. Three factors were identified to make informed decisions relating to the future improvement for the implementation eConnect and Learn program in the classrooms. The first focussed on evidence-based research by a strong knowledgeable ICT team which should be led by qualified researchers. The team should include teachers from each secondary school as well as ICT technicians, school supervisors, parents, students, and interested members of the community. Their major task should be to discuss observations made on issues which enhance/negate effective use of the eConnect and Learn program in the class and the school-wide level. Data should be collected in a timely manner. Analysis of data by the qualified researchers should be submitted to the school supervisors who should take the responsibility to discuss and share the results at the monthly principal's conference in each educational district. Informed decisions should be made to implement effective use of the future of the eConnect and Learn program.

The second factor encouraged teachers to upgrade their ICT skills on a regular basis. Certification for courses completed is required as an incentive for teachers to continue learning about the integration of ICT in the classroom. This should contribute to the improvement for the future use of the eConnect and Learn program. The third factor suggested best practices should be highlighted, collected, and used as online open education resources. These can be modelled, or modified for future curriculum activities.

The following excerpts supported these proposals.

IS19CG: 9 Nothing was put in place by the Ministry of Education in terms of school policy for security and everything else.

IS3CG, 177: Such great pieces of work come out from the kids, and they are shelved. I am hoping to see that the Ministry uses the best practices from different schools and be able to make a team that the Ministry can depend on for resources to further develop … the Ministry must recognise the talents and the abilities of their students to actually push ICT forward in that direction.

IS13FD, 102: But to do something and not receiving certification or is not credited doesn't prove to be an incentive for any future courses that may be offered the same way. So I think it is very important.

4.13 Summary of Qualitative Analysis

The overarching theme, concerns for the eConnect and Learn program, explored implications for the future of the program under five categories: enhancing professional education; students' engagement with laptop computers; resources; infrastructure; and future improvement for the implementation of the eConnect and Learn program. Based on the reported experiences and perceptions of teachers and students' use of the eConnect and Learn program, a number of valuable suggestions were proposed. Implementation of these proposals have the potential to enhance the teaching and learning with ICT in the Trinidad and Tobago schools.

4.14 Summary of Chapter 4

Chapter 4 provided evidence, understanding, and insight of the impact of ICT on teachers' pedagogical content practices. This was made possible through a mixed methods methodology. Findings from the analyses of the survey scores revealed pre-service teachers who were in their final year (2013-2014) preparing for an undergraduate degree were more confident and knowledgeable to integrate ICT than in-service teachers who were already qualified with an undergraduate degree. The results also suggested teachers who had recently joined the teaching service were more proficient in the application of ICT than their colleagues who had more years of teaching experience. A comparison of TPACK survey scores between pre-service teachers in Trinidad and Tobago and Australia suggested a high level of consistency among 14 out of 20 items for the two cohorts.

An analysis of the qualitative data revealed the introduction of the eConnect and Learn program into the schools was introduced with only a limited structured plan. The teachers suggested the program was "handicapped" by inadequate support for professional development, insufficient resources, and poor infrastructure. This in turn led teachers to become less motivated to be engaged with the eConnect and Learn program. Some of them continued with the traditional 'talk and chalk' delivery method of their content materials. In contrast, others become motivated by the program and bought their own computers, scanners, LCD projectors and printers. Some teachers also independently participated in online professional development associated with technology use in classrooms. They were also connecting with other teachers and e-teaching resources located in other countries. These results suggested that the eConnect and Learn program is being unevenly implemented in Trinidad and Tobago schools and has been overly dependent on individual teachers and individual schools taking the initiative on how they will use and engage with eLearning.

CHAPTER 5: DISCUSSION

5.1 Introduction

Proponents of educational technology, such as Lemke and Coughlin (1998) articulated that under the right conditions technology can accelerate, enrich, and deepen basic skills as well as motivate and engage students in learning. High expectations were held with the introduction of technology programs for ICT integration in schools. Although these programs allowed for rapid access to useful information, teachers and policy makers should be knowledgeable of how this information could be used to engage students in constructing new learning in innovative and exciting ways (Finger et al., 2007; Grimes & Warschauer, 2008). The eConnect and Learn program in Trinidad and Tobago has yet to achieve these goals. The rationale for this inference was demonstrated by research-based evidence presented from the eight research questions in the previous chapter.

This chapter reviews and discusses the results from Chapter 4. The in-depth and contextualised insights and findings associated with the interviews are used as a platform to better explain, understand, and build on the quantitative results (Creswell & Clark 2007). The findings are synthesised and positioned within the existing corpus of literature to summarise the contributions they have made in the research field. Based on evidence gathered from this research, a new framework, LEM-LT, is presented to enhance and simultaneously enable teachers to self-reflect on how they are using digital tools in the classroom. Limitations of the study are also presented. The chapter ends with the implications for the future of the eConnect and Learn program.

The eight research questions are utilised as a framework to guide the presentation of this chapter. The discussion for Research Questions 3 and 4 are combined and presented simultaneously. This was deliberately done to produce a bigger picture and better understanding of the results of the two research questions than one stand-alone description. Discussion of each research question draws upon its results as well as relevant findings of the other research questions and the interview data to provide deeper understanding and a broader picture of the whole study.

5.2 Relationship of TK, TPK/TCK, and TPACK scores

Research Question 1: *Based on teachers' survey results, what is the relationship between their TK, TPK/TCK, and TPACK scores?*

Scatter plots generated in Research Question 1 indicated there was a strong correlation among the TK, TPK/TCK and TPACK scores: $r = .88$ for TPK/TCK and TPACK; $r = .79$ for TK and TPK/TCK; $r = .77$ for TK and TPACK. The strong positive linear relationship hypothesised that as technology integration knowledge increased for teaching and learning there was a corresponding increase in confidence and development of technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK). This relationship was demonstrated in this study by the differences in confidence of technology integration by pre-service and in-service teachers.

Pre-service teachers learned about educational technology and instructional design courses for ICT integration in teaching and learning at the University of Trinidad and Tobago. In contrast, in-service teachers explored the functioning dimensions of computers and related devices during seminars and workshops as indicated in the analysis of the interview data. The difference in ICT integration between the two cohorts suggested pre-service teachers had acquired deeper technological integration knowledge at the university. As a result they were more confident in the application of technological pedagogical content knowledge; this was reflected by the higher scores obtained in the TK and TPACK surveys by pre-service teachers as compared to in-service teachers.

The hypothesised relationship of the variables deduced from the findings in Research Question 1 was also evident for in-service teachers who were recent graduates from the university. Teachers with less than 10 years of teaching experience in secondary schools were more confident to integrate ICT than their peers who had more than 10 years of teaching experience. The rationale for these differences were further discussed under Research Questions 2, 3, and 4.

5.3 Teachers' Confidence to use ICT

Research Question 2: *How confident are pre-service and in-service teachers to use ICT as determined by the TK, TPK/TCK and TPACK surveys?*

Results from three separate independent-samples *t*-tests (two-tailed) revealed pre-service teachers had higher mean scores than in-service teachers for every item on the TK, TPK/TCK, and TPACK scales. The value of mean scores for confidence to use ICT for supporting pedagogical practices in the delivery of content knowledge was highest for TK (M = *5.25*), followed by TPK/TCK (M = 4.72), and TPACK (M = 4.72) by pre-service teachers. The value of mean scores for in-service teachers in the same areas were: TK (M = 4.27), TPK/TCK (M = 3.80), and TPACK (M = 3.62). These results disputed pre-service and in-service teachers' perception of their confidence for ICT integration. Results from the analysis of the interview session revealed in-service teachers perceive they were more confident to integrate ICT as compared to pre-service teachers. In addition, both cohorts responded they had little understanding of TPACK but their greatest difference in this area was 1.26 according to *Cohen's d*, and as demonstrated in Table 25 on page 151. These results were discussed and compared to findings from other studies from a global perspective and from a national perspective. The latter is explored under teacher support from a Trinidad and Tobago's perspective.

5.3.1 Global comparisons.

The results obtained by the independent-samples t-test related to pre-service teachers' ICT integration knowledge challenged findings obtained in other studies. Finger et al. (2010) reported two out of every five students leaving initial teacher education programs at two universities in Australia had no confidence or just some confidence to use ICT for teaching and learning. Tersptra (2010) concluded in her study that although pre-service teachers use digital technologies in their personal lives on a daily basis, they fail to use their technological knowledge in the preparation of their own teaching. Kay (2006) and Swain (2006) articulated many pre-service teachers were not adequately prepared to use ICT in classrooms.

In contrast, a study in Scotland (Williams et al., 2000) reported although there was low use of ICT, overall teachers were generally positive and the majority wanted to develop their ICT skills and knowledge. In this study, findings revealed pre-service teachers had more confidence than in-service teachers to integrate computers, multi-media devices, word processing, and digital/document camera. As Lloyd (2013) expressed in her study, pre-service teachers generally displayed high levels of competence and highly positive dispositions to the integration of ICT in their future classrooms.

5.3.2 Teacher support.

During the interview sessions in this study, pre-service teachers articulated they had completed Educational Technology and Instructional Design courses. These courses provided theoretical and practical understanding as well as insights of writing lesson plans and ways to disseminate instructions to students during their practicum (learning experience) periods. In contrast, in-service teachers reported workshops and seminars related to the use of computers and digital technology were conducted only at the initial introduction of the eConnect and Learn program in 2010 for five hours for five days and dwindled after the first year. They were introduced to Microsoft Photo Story, eBeam, and Google Docs and explored websites such as Edmodo, WebQuest, and Pennacool. They perceived there was insufficient time to practice, develop, and integrate what they learn at the workshops and seminars. This prevented full understanding and development of technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2008). Time for collaboration and appropriate on-going professional learning are essential factors which contribute to make programs meaningful to teachers and students (Drayton, Falk, Stroud, Hobbs, & Hammerman, 2010). The way teachers infuse technology in their teaching and learning will determine their confidence and consequently the success of the eConnect and Learn program.

The analyses of in-service teachers' interview data also suggested infrastructure and relevant resources were partially provided to support teachers' pedagogical practices and student learning with ICT. As a result of inadequate support, tension arose between teachers' enthusiasm to integrate the eConnect and Learn program and the necessities to underpin the transformation of teaching and learning in more creative ways. Just enough support was provided by administrators and the Ministry of Education to get teachers and students interested in the program. This had its advantages and disadvantages. In order to fill the gap for available resources, 15 % of teachers bought their own computers, printers and LCD projectors. One teacher independently attained technological professional education through online webinars. On the other hand, the use of the affordances of the eConnect and Learn program were met with resistance by some teachers. They continued with the 'talk and chalk' method and refused to deal with the challenges of infrastructure, resources, professional training and time for collaboration. This was reflected by in-service teachers' lower mean scores for TK, TPK/TCK, and TPACK items. Pre-service teachers who were educated in technology integration and instructional design for teaching and learning developed more confidence in ICT and had a higher value of mean scores on the surveys.

5.4 Teaching experience, school category, instructional areas, and qualifications

As mentioned before, Research Questions 3 and 4 will be discussed together to present more detailed information of the impact of teaching experience, school category, instructional content areas and qualification on teachers' TK, TPK/TCK, and TPACK scores.

Research Questions 3: *Do teaching experience and school category impact upon teachers' TK, TPK/TCK, and TPACK scores?*

Results from the analysis of variance (ANOVA) in Research Question 3 revealed there was a significant difference for the value of TK, TPK/TCK, and TPACK scores for teaching experience in secondary schools. According to the Scheffe post hoc tests, teachers who were employed for less than 10 years obtained higher value of mean scores than those who were employed for more than 10 years. School category, government and denominational schools, did not impact on teachers' mean scores for TK, TPK/TCK and TPACK.

Research Question 4: *Do instructional content areas and qualifications impact upon teachers' TK, TPK/TCK, and TPACK scores?*

Results from the multivariate analysis of variance (MANOVA) in Research Question 4 indicated there was a statistically significant difference for qualification level on each dependent variable: TK, TPK/TCK, and TPACK. Pre-service teachers obtained higher value of mean scores than in-service teachers in the instructional content areas, Mathematics, Science and Humanities. Instructional content areas did not impact on teachers' mean scores for TK, TPK/TCK, and TPACK.

Three areas associated with the findings for the ANOVA in Research Question 3 and the MANOVA in Research Question 4 were:

- Structural organisation of teacher certification and employment in secondary schools.
- Teaching experience.
- Curriculum adaptation.

5.4.1 Structural organisation of teacher certification and employment in Trinidad and Tobago.

At the time of data collection for this study in 2013, pre-service teachers were in their final year studying for an undergraduate degree inclusive of teacher certification. A total of 86% of the in-service teachers were qualified with an academic degree. Among these only 45% had graduated with teacher certification. In addition, a total of 14% had graduated with a Master degree. Among these 5% were qualified with teacher certification. This is the norm in the country where one can be employed as a teacher without teacher certification. After a period of three to five years of employment in secondary schools, teachers were selected to complete a Diploma of Education on a part-time basis at the University of the West Indies, (UWI, 2015) with a regional campus located in Trinidad and Tobago. The course was conducted once per week for a year, where teachers learned about the theoretical and practical aspects of pedagogy. As such, in-service teachers' acquired pedagogical content knowledge but lacked professional training in the integration of TK, TPK/TCK, and TPACK.

Educational transformation of a new model of teacher education was introduced in Trinidad and Tobago in 2006 (Gowrie & Ramdass, 2012; MOE, 2004; Steinbach, 2012; Walker, 2012). For the first time two campuses at the national university, the University of Trinidad and Tobago, offered a four-year full time Bachelor of Education degree. The course provided opportunities to complete an academic degree inclusive of teacher certification. As a result, there were two cohorts of in-service teachers in the country at the time of this study: those qualified with only an academic degree and those with an academic degree with teacher certification. By 2010, the first cohort of teachers with an academic degree and teacher qualification had graduated from the University of Trinidad and Tobago for employment in primary and secondary schools. The number of graduates for secondary schools was inadequate to supply the demand for teachers. Consequently, the Ministry of Education continued to employ teachers with an academic degree without formal teacher certification in secondary schools.

5.4.2 Teaching experience.

Teachers with less than 10 years of teaching experience in this study were recent graduates from the University of Trinidad and Tobago and the University of the West Indies. Those from the former university were instructed in educational technology and instructional design courses which underpinned technological pedagogical knowledge, technological content knowledge, and technological pedagogical content knowledge. There is some evidence that teachers who have acquired higher levels of technological skills are more motivated to use technology in the classroom (Finger et al., 2013; Hammond et al., 2009; Jamieson-Proctor et al., 2007; Paraskeva, Bouta, & Papagianna, 2008). This study supports these finding; the Trinidad and Tobago graduates with more technology experience reported being more confident with using technology in their teaching.

The Fitzallen and Brown (2006) finding that teachers with less years of teaching experience but with more technological knowledge were more influenced by their teacher education experience. They were also influenced by the rapid explosion of ICT in the community to use technology in their classrooms. The findings in this research are generally supportive of the Fitzallen and Brown research, with pre-service teachers and those teachers with less than 10 years of teaching experience in Trinidad and Tobago being more willing to engage with eLearning.

The ANOVA and MANOVA reflected higher mean scores for TK, TPK/TCK, and TPACK for pre-service teachers and those with less than 10 years of teaching experience. According to Singh (2010), programs for pre-service teachers at the University of Trinidad and Tobago have the potential to relate to diverse cultures with the knowledge, skills and abilities to better provide equity in technology driven classrooms where all children can be engaged and empowered to learn.

5.4.3 Curriculum adaptation.

The findings for Research Questions 3 and 4 can also be contributed to a shift in curriculum adaptation in 2008 at the University of Trinidad and Tobago. Final year pre-service teachers reported they learned how to integrate the concepts they wanted to introduce and strategies they implemented, with the selection of appropriate technological tools for their teaching and student learning. This was a positive move to integrate technology into their teacher education programs (Gowrie & Ramdass, 2012; Steinbach, 2012). On this point, the evidence is teacher educators need to be constantly thinking about adapting, evaluating and redesigning their pre-service and on-going teacher education programs in order to demonstrate effective ICT integration (Goktas, Yildirim, & Yildirim, 2009).

From the interview sessions, in-service teachers reported they wanted more ideas and strategies associated with integrating technology into their teaching and students' learning. This is not a new call with previous researchers noting that teachers with less than 10 years of teaching experience were more motivated to transform their teaching and student learning with the integration of ICT (Lemke & Coughlin, 1998). These findings were also similar to those reported by Jamieson-Proctor and Finger (2008) and Liang et al. (2013). In particular, Jamieson-Proctor and Finger (2008) noted teachers with less than 10 years of teaching experience were more confident to use ICT for teaching and learning in Catholic schools in Queensland, Australia. In the Liang et al. (2013) study, the more senior preschool teachers showed a certain degree of resistance toward technology-integrated teaching environments.

In the present study it is noted that while the newer teachers in Trinidad and Tobago were more confident about e-technology in the classroom, the teachers already in the schools had a stronger idea about where they could use the e-technology. This suggests that as teachers become more experienced with the needs of their students they are more able to use their pedagogical content knowledge to select the most appropriate teaching resources to match the needs of their students (Shulman, 1986). The Ministry of Education in Trinidad and Tobago should think about strategies to help in-service teachers to inculcate ways to facilitate a variety of appropriate digital media and formats to communicate information and new ways to design lesson plans and assessments that incorporate ICT use by students.

Research Question 5: *What are the factor structures of the teacher surveys?*

Principal Component Analysis (PCA) and Varimax with Kaiser Normalization as the rotation method were conducted to explore the factor structures of the TK, TPK/TCK and TPACK scales. Parallel analysis (Horn, 1965; Pallant, 2013) was performed to confirm the number of factors on each scale. The results revealed a single factor solution was present for each scale with the common thread of confidence to use ICT. In this study the one factor solution for TK was labelled "confidence to use ICT," for TPK/TCK, it was labelled "professional practice and pedagogy," whereas for TPACK it was labelled "support for students' learning." The one-factor solution indicated the items in each scale measured the same underlying construct.

Furthermore, the reliability of the three surveys had strong internal consistency. This was measured by Cronbach's reliability coefficient which is also known as alpha (α). The alpha values obtained were: (α)TK =.94; (α)TPK/TCK = .98; and (α)TPACK = .98. These values indicated the surveys were free from errors and were reliable to perform further statistical tests. The alpha values from this study were consistent with results obtained for the TTF TPACK survey (Jamieson-Proctor et al., 2013) which was slightly adapted for this study: α (TPK/TCK) = .97 and α (TPACK) = 99. Similar alpha values were reflected in the survey which was constructed and validated by Schmidt et al. (2009): α (TK) = .82; α (TPK) = .86; α (TCK) = .80 and α (TPACK) = .92. The survey by Graham et al. (2009) also confirmed strong alpha values: α (TK) = .92; α TCK) = 0.91, α (TPK) = 0.97, and α (TPACK) = .95. According to George and Mallery (2003), such alpha values could be regarded as strong and demonstrate internal survey consistency.

5.5 Positioning Trinidad and Tobago Pre-service Teachers on an International Level

Research Question 6*: What is the comparison of pre-service teachers' TPACK scores from Australia and Trinidad and Tobago?*

Pre-service teachers in Trinidad and Tobago compared with pre-service teachers in Australia interpreted and completed the TPACK survey in a similar way. A total of 6 out of the 20 survey items demonstrated a significant difference between the two cohorts by *Z* score. Australian pre-service teachers had higher mean scores for five items: (1) Provide motivation for curriculum tasks; (2) Synthesise their knowledge; (3) Demonstrate what they have learned; (4) Engage in independent learning through access to education at a time, place and pace of their own choosing; and (5) Understand and participate in the changing knowledge economy. The Trinidad and Tobago pre-service teachers had higher mean score for the item: Support elements of the learning process. The rationale for the similarities and differences in pre-service teachers' responses are reviewed below.

5.4.4 Comparison of both cohorts.

Pre-service teachers from the two countries were final year candidates in the Bachelor of Education degree (B.Ed.). Those in Trinidad and Tobago participated in face-to-face courses, whereas the Australian pre-service teachers pursued their courses either face-to-face and/or online. The indications are that the pre-service teachers in Australia had more experience with eLearning and digital technology as a regular part of their University program of study and this may have influenced their responses in the survey. Because of this involvement and experience, the Australian pre-service teachers perceived that eLearning had the capacity and the potential to: (1) provide motivation for curriculum tasks; (2) synthesise knowledge; (3) demonstrate what students have learned; (4) help students to engage in independent learning through access to education at a time, place and pace of their own choosing; and (5) and help students to understand and participate in the changing knowledge economy. It was only the item: Support elements of the learning process, in which the Trinidad and Tobago pre-service teachers scored higher. It could be because this question referred to "elements of learning." The Australian teachers who regularly engaged with eLearning may have interpreted this question as meaning eLearning only had a narrow focus.

Both cohorts of pre-service teachers completed approximately 12 weeks in practice teaching in schools over the four years of their degree. Both courses had units of study related to technology, for example, in Australia ICT and Pedagogy, unit of study (subject) was offered at the Australian Universities (Albion, 2012). The Trinidad and Tobago pre-service teachers completed the units Instructional Design and Educational Technology in the third year of their program of study.

5.4.5 Teaching resources.

Pre-service teachers in both countries had some access to the world-wide-web. Australian pre-service teachers had access to exemplar packages to frame digital professional learning and curriculum resources for the integration of ICT in English, Mathematics, Science and History (Australian Institute for Teaching and School Leadership [AITSL], 2014). Additionally resources from active websites, such as Scootle (https://www.scootle) and learning platforms, such as Moodle (http:// moodle.org) were available to them.

Trinidad and Tobago pre-service teachers learned to integrate Mahara and Voki in their pedagogical practices. Mahara helped them to build their ePortfolio system whereas Voki provided the opportunity for creating avatars which can perform tasks, such as giving instructions for students to work on certain projects. They accessed videos in instructional content areas from the website Make Me Genius. Components of Microsoft Office suite, such as word, excel, PowerPoint, Outlook, Spread Sheet and Publisher were available for both cohort of teachers. In addition, Web 2.0 tools supported new ways for them to create, collaborate, edit, and share content online. It is assumed that the availability of these resources and participation in technological courses have contributed to a high level of consistency in confidence for technological pedagogical content knowledge between both the Australian and the Trinidad and Tobago cohorts of pre-service teachers.

5.4.6 Research impact on pre-service teachers' ICT integration.

Australia has a history of investigating pre-service teachers' experiences in the application of ICT in pedagogy; explore the barriers encountered in technology integration for teacher education; oversee the challenges in teaching practicum; and investigate ways to improve pre-service teachers' education (Department of Education Employment and Workplace Relations, 2009). Such investigations have helped to highlight the importance of ICT integration into schools and into teacher education in Australia (AITSL, 2011; AISTL, 2014). This research has in part influenced the development of the Teaching Teachers for the Future (TTF) TPACK survey instrument (Jamieson-Proctor et al., 2013)

The introduction of the eConnect and Learn program into Trinidad and Tobago schools may have indirectly helped to focus on the issue of how pre-service teachers were, and are being prepared to integrate ICT in the curriculum areas. The major educational goal of the program emphasised improvement of the quality of instruction by, in part, the infusion of ICT into teachers' pedagogical content practices, and to help to develop teaching and learning practices associated with the 21st Century knowledge economy (Gopeesingh, 2010a). In addition, the Trinidad and Tobago Ministry of Education developed the draft ICT Professional Development Implementation Plan for Educators in 2010. This plan emphasised pre-service teachers should participate in specialized courses in ICT Integration, plus ICT focus in subject-specific courses, such as Information Technology.

The involvement of the Department of Education, Employment and Workplace Relations in Australia and the Ministry of Education in Trinidad and Tobago contributed positively to ICT integration results in the respective countries. Pre-service teachers from both countries were knowledgeable about ICT integration for pedagogical content knowledge. This was reflected by the computed *Z* scores of the items on the TPACK survey instrument.

5.5 Moersch's (2010) Levels of Teaching Innovation

Research Question 7: *Can Moersch's (2010) Levels of Teaching Innovation be used to review and interpret teachers' interview data relating to pedagogical practices with computers and related devices?*

Research Question 7 focussed on pedagogical practices with computers and related devices by in-service teachers in secondary schools. This research question was analysed under three sections. The first was an overview of teachers' perception of first order barriers in the learning environment for ICT integration. This was drawn from the findings of data analysis of teachers' interviews. The second section discussed the policies developed to facilitate ICT integration as outlined for the eConnect and Learn program by the Minister of Education (Gopeesingh, 2010a). These were important to make comparison with results of the review and interpretation of teachers' pedagogical practices with ICT as inferred by the Levels of Teaching Innovation. Finally, the third section utilised these findings as evidence to indicate the implementation stage of the eConnect and Learn program in Trinidad and Tobago.

5.5.1 First order barriers.

Data analysis relating to the structural organisation in the learning environment suggested first order barriers (Ertmer, 1999) had prevented the full implementation of the eConnect and Learn program in secondary schools. As previously discussed, barriers included lack of appropriate infrastructure; inadequate resources; insufficient professional education for ICT integration; infrequent collaboration among teachers to share experiences of the use of the eConnect and Learn program; and too little time allocated to practice what was learned. Because of these first order barriers, school leaders in Trinidad and Tobago were constrained to lead, plan and foster a technologically collaborative school culture. Teachers too encountered challenges to innovate broadly and deeply in curriculum activities. Their competencies to access information freely from the World Wide Web, and to challenge their students in new ways of constructing knowledge and skills for 21st Century learning were limited. These findings were consistent with other studies (Ali, 2013; Briggs, 2013; Onuoha, 2014; Sankar, 2014) on the eConnect and Learn program. For example, analysis of the in-service teachers' interview data in this study revealed teachers' pedagogical practices were mainly PowerPoint, videos, "talk and chalk," drills and tutorials. In addition, the teachers had little understanding as well as a lack of conceptualization of integrating technological knowledge with their pedagogical and their content knowledge. This was confirmed by their responses when they were asked to explain the meaning of technological pedagogical content knowledge (TPACK) (see Table 26).

Although it is easy to be critical of teachers, teaching is a complex profession (Shulman, 1986) and rather than blame teachers, particularly in settings with limited resources and support, the need is to facilitate and support those teachers (Gopeesingh, 2010b). The teachers in this study have, to date, been give few opportunities to change the ways pedagogies were implemented to improve student learning for constructing new knowledge in innovative and exciting ways. Although this knowledge is available (i.e., Finger et al., 2007; Grimes & Warschauer, 2008), how teachers in developing countries or countries with limited technology support access this knowledge is an issue, and so access to technology pedagogical content knowledge remains a first order barrier. First order barriers for technology integration were also articulated by other researchers in their studies (Darling-Hammond, Bransford, LePage, Hammerness, & Duffy, 2005; Roblyer, 2006). First order barriers associated with access to knowledge and resources often results in variation in the rate of implementation of technology into the classroom (Muir, Knezek, & Christensen, 2004) and it is a feature of this study's research findings.

Fruitful results were achieved within 1.5 to 2.5 years with the one-to-one computing programs. Muir, Knezek, and Christensen (2004) acknowledged the program in Middle School classes in the State of Maine, USA was successful because it targeted four critical factors: access to technology; focus on learning; emphasis on leadership; and context-embedded professional development. The study reported positive changes in students' attitude, less referrals; improved work habits; and greater community support. Results from a study in California found the greatest improvement was in the second year of the one-to-one program (Dunleavy & Heinecke, 2008; Warschauer & Grimes, 2005).

On the other hand, some studies have demonstrated more positive outcomes and results after a longer implementation period. For example, the three-year study of the one-to-one laptop program, 'Emerge', was conducted in Canada. Results revealed a positive impact (Alberta Education, 2010). This positive impact could be the Canadian teachers' technology skills and knowledge and the technology infrastructure in Canada facilitated its introduction. The Canadian Emerge study differed from the eConnect and Learn program, because only some of the students involved in the Canadian program were allowed to take the computers home. After three years into the program, Canadian students significantly increased their capability and expertise to utilise 21st Century skills in a highly complex global society. Canadian teachers too, shifted from a technological approach to a pedagogical approach and engaged their students in relevant learning at a deep and complex level. Yet, another study by Drayton et al. (2010) reported although there were some positive effects after five years into the one-to-one computing program for Grades 8 and 9 students in Boston, some first order barriers still existed. Professional development models were not structured to give teachers enough time to collaborate among their peers within the schools' environment and outside schools to discuss and develop best practices for pedagogical approaches.

To provide deeper insights and better understanding for the level of implementation of the eConnect and Learn program in Trinidad and Tobago, two policies outlined by the Ministry of Education (MOE, 2010a) were examined. The first was the eConnect and Learn policy and the second was the ICT- Professional Development Implementation Plan (ICT-PDIP) for Educators (MOE, 2010b). These two policies will now be reviewed.

5.5.2 Policies to facilitate the eConnect and Learn program.

The eConnect and Learn policy.

The eConnect and Learn policy outlined three hierarchical objectives to inform teachers of different ways to integrate computers and related devices for student learning:

(1). Computer-assisted instruction, which consisted of demonstration, drill and practice, tutorials, simulations and interactive activities, graphical representations of math equations and collaborative activities.

(2). Resource-based learning which focussed on the achievement of subject areas and information literacy objectives through exposure to and practice with diverse resources, making students active learners.

(3). Collaborative learning organised for learners to communicate and work with their peers both inside the classroom and across classrooms and schools in projects designed to solve real-world problems through the application of subject-specific knowledge and skills.

The first objective reflected surface level knowledge (Biggs & Tang, 2011) of the use of computers and related devices. It focussed on add-on activities similar to technological versions of workbook approaches (Hadley & Sheingold, 1993). The objective reflected low-levels of technology integration: enhancement, reinforcement, and extension activities (Moersch, 2010). The second objective emphasised resource-based learning for students in terms of the acquisition of instructional content knowledge and information literacy. The Ministry of Education anticipated computer-based resources would provide for a “transformation of students’ learning.” That is, having students able to access technology via the computer was considered necessary. The issue (as identified in this research) reflects while this computer technology may be necessary, it is not sufficient to provide for a “transformation of students’ learning” unless teachers’ knowledge and practices are also addressed. For example, after three years into the eConnect and Learn program, most teachers were not given personalized laptop computers for their use at school and to plan curriculum activities at home. Furthermore, the school policy made teachers apply in advance to access laptop computers, LCD projectors, and scanners. Interactive whiteboards and software for teaching and learning were still absent from the classrooms.

The second objective of eConnect and Learn program, focussed on students' learning but less on the teachers' learning, or on the teaching resources required for ICT integration into pedagogical practices.

The third objective of the eConnect and Learn program, described higher order cognitive skills which require creativity and innovation, critical thinking and problem solving for the 21st Century knowledge economy. Although this is stated in the policy, such goals are not specific to the eConnect and Learn program and have been articulated in a number of educational settings with reference to technology and eLearning (ACOT2, 2008; Biggs & Tang, 2011; Finger et al., 2013). The focus of the problem shows creative, critical and deep thinking require students to have access to and to engage with a sophisticated curriculum that values and supports such initiatives. While the computer as a tool, has the potential to facilitate students' creative, critical and deep thinking, computers are just tools and how they are used by teachers within a wider curriculum and assessment framework is the critical factor.

ICT Professional Development Implementation Plan (ICT-PDIP) for Educators.

The second policy, ICT Professional Development Implementation Plan (ICT-PDIP) for Educators (MOE, 2010b) focussed on professional ICT development for in-service and pre-service teachers, curriculum officers, principals, ICT technicians, and a cadre of students to support ICT in each classroom in secondary schools. The policy was patterned after three principles of UNESCO ICT Competency Standards for Teachers (UNESCO, 2008): Technology Literacy, Knowledge Deepening and Knowledge Creation. The anticipated achievement of the three principles was theoretically and carefully planned in detail through different ICT media: face-to-face, online, blended learning, WebQuests, and open educational resources repository wherever necessary. ICT-PDIP goals were developed to sustain internet connectivity, personal laptop computers, and provide an email address using the school's domain for each teacher. A number of local and international organisations were listed for recruitment to assist with the implementation of ICT professional development: University of Trinidad and Tobago (https://u.tt/); the National Energy Skills Centre (http://www.nesctt.org/training-centre/); the University of the West Indies (http://sta.uwi.edu/); SchoolNet South Africa (http://www.schoolnet.org.za/); and Commonwealth of Learning (http://www.col.org/about/whatis/Pages/default.aspx). Provision for monitoring and evaluation of ICT professional development was also outlined but there was no mention of teachers' development of technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2008). In addition, there were no measures to aid teachers to reflect on their application of ICT integration such as Moersch (2010) Levels of Teaching Innovation.

In 2010, the government of Trinidad and Tobago had educated 2000 teachers as "trainers" for ICT integration (Gopeesingh, 2010b). Even so, according to the analysis of the interview data, the results revealed "trainers" for teacher development program focussed mainly on the functional and exploratory use of the computers. In reality, it may have been better if more emphasis had been placed on providing professional learning opportunities for teachers on how to integrate ICT in productive ways (Getenet, Beswick, & Callingham, 2014).

The Trinidad and Tobago Ministry of Education hoped all teachers would master the first principle, Technology Literacy, by 2014 as noted in the ICT-Professional Development Implementation Plan for Educators. Technology Literacy was explained as the integration of basic ICT tools into the curriculum. At the end of that same period, the Minister of Education expected 50% of in-service teachers and all pre-service teachers to develop the second principle, Knowledge Deepening. This principle has the potential to provide teachers with the knowledge and skills to use more complex methodologies and technologies. It was identified in this research the pre-service teachers and in-service teachers with less than 10 years of teaching experience had fulfilled the expectation of Knowledge Deepening as discussed previously in Research Questions 3 and 4. In-service teachers with more than 10 years of teaching experience were yet to achieve this principle. No mention was made by the Minister of Education for the achievement of the third principle, Knowledge Creation, which is described as developing 21st Century skills for students, and sophisticated skills of using technology for teachers. These were the expectations listed in ICT- Professional Development Implementation Plan for Educators for the fourth year (2014) after the introduction of the eConnect and Learn program. It could be argued the three ICT Trinidad and Tobago stages of ICT integration principles: Technology Literacy, Knowledge Deepening and Knowledge Creation had a hierarchical development of ICT usage which reflected in part three stages of ICT integration relating to Moersch's (2010) Levels of Teaching Innovation.

5.5.3 Comparison of ICT-PDIP with the Levels of Teaching Innovation.

Technology Literacy, Knowledge Deepening, and Knowledge Creation of the ICT Professional Development Implementation Plan for Educators (ICT-PDIP) have a defining relationship with the eight Levels of Teaching Innovation in relation to Trinidad and Tobago teachers' pedagogical practices with computers and related devices. Technology Literacy corresponded to Awareness and Exploration dimensions of the Levels of Teaching Innovation. These dimensions described the application of digital tools and resources for lower cognitive development skills. When teachers were asked how they integrated computers and related devices for teaching and learning during the interview sessions, 43% of the responses were at the Awareness Level and 18% were at the Exploration Level. The second principle, Knowledge Deepening corresponded to the Level 3, Infusion stage of the Levels of Teaching Innovation. This dimension outlined a shift away from teacher-centred, lecture-based instruction toward student-centred, interactive constructivist learning. A total of 16% of responses to how teachers used ICT for their pedagogical content practices were at this level. The third principle, Knowledge Creation corresponded to the other four dimensions of the Levels of Teaching Innovation: Integration Mechanical, Integration Routine, Expansion, and Refinement. Only 2% of teachers' responses were at each of these higher order cognitive skills level. This suggests Trinidad and Tobago teachers had yet to accomplish all the skills to fully integrate technology into their pedagogical content practices. In particular, the Trinidad and Tobago teachers reported they had difficulty in differentiating the curriculum to meet students' individual needs based on their interest and aspiration.

When teachers were asked how confident they were to integrate ICT, a total of 43% of in-service teachers reported they were above moderately confident to use ICT, yet they displayed little understanding of how to use a wide range of technological tools to accomplish constructivist approaches. This was reflected in their perception of ICT with the highest responses in Layer 1 which corresponded to the Awareness level (Level 2) of the Levels of Teaching Innovation. Although one teacher encouraged critical thinking, collaboration and problem solving in dance movements in the Mechanical Integration level (Level 4), there was little reflection of metacognitive skills development and innovation. Minimal knowledge, confidence and responses for the application of the four most complex dimensions of the Levels of Teaching Innovation were displayed. At these dimensions, the promotion of inquiry-based models of teaching and learner-centred strategies for the development of students' metacognitive skills, creativity, innovation, critical thinking, problem solving, and value beyond the schools were incorporated minimally by Trinidad and Tobago in-service teachers.

Amidst all the planning, results from teachers' pedagogical practices with computers and related devices reflected strategies between the Awareness and Infusion dimensions of the Levels of Teaching Innovation (Moersch, 2010). This was the same level the Ministry of Education expected in-service teachers to achieve by 2014, mastering Technology Literacy and commence Knowledge Deepening. Higher ICT integration levels were not targeted for teachers and their students. In addition, the goals for the ICT Professional Development Implementation Plan for Educators relating to sustainability of internet connectivity, personal laptop computers and school's email address for each teacher were not provided by 2013. These factors seem to have prevented the full implementation of the eConnect and Learn program at a micro level in the classroom and at the macro level in the schools and across the educational system.

5.5.4 Implementation of the eConnect and Learn program.

According to Rogers (2002) diffusion of innovations theory, a new innovation, goes through a continuum of processes before its full use or rejection takes place. The diffusion of the eConnect and Learn program is an example. For an innovation to be effectively implemented, Rogers (2002) argued that the complexity of implementation had to be addressed, a process Rogers called "trialability." It seems that the eConnect and Learn program had not been well piloted in schools before it was implemented across the country. Similar to Rogers (2002), the Concerns-Based Adoption Model (Hall & Hord, 1987) also argued that a new innovation has to be supported and resourced. In terms of the implementation of the eConnect and Learn program, such resources could have included: appropriate infrastructure; professional development; curriculum support; technology support and resources, time allocation to practice and learn about ICT resources, and collaborate among peers. The Levels of Teaching Innovation (Moersch, 2010), acknowledges these critical factors can impact upon teachers' performance and adoption of the program.

Based on the discussion of the eConnect and Learn program, the indications are that the teachers' competencies with the eConnect and Learn program were located around the Awareness level and the Infusion level of the Levels of Teaching Innovation. This is, still at the early stages of implementation. These results suggested that teachers in Trinidad and Tobago still need more support to facilitate greater adoption and implementation of the program. This study also suggested that Moersch's (2010) Levels of Teaching Innovation have the potential to assist in the implementation of future versions of the eConnect and Learn program by linking the integration of ICT in the classroom to a corresponding Level of Teaching Innovation.

5.6 Implications for the future of the eConnect and Learn program

Research Question 8: *What implications are there for the future of the eConnect and Learn program in Trinidad and Tobago?*

Based on the participants' experiences of the eConnect and Learn program, implications for the future of the program were examined. Four major implications were identified through the results of the analyses of the interviews: student engagement with the laptop computers, professional development and resources, and open repositories for best pedagogical practices. These were discussed in relation to other studies. Proposals were made based on each finding.

5.6.1 Student engagement with the laptop computers.

Teachers in Trinidad and Tobago observed students played games with their laptop computers and became less socialised with their peers. In contrast, a study conducted in Paraguay found the one laptop per child program brought an atmosphere of friendship, sharing and collaboration (Severin & Capota, 2011). In another study by Lei (2010) from Syracuse University revealed a program was set up where all students had access to computers in a ubiquitous computing project. During the first year students played games and were off task. As the novelty wore off positive changes evolved and students became more computer proficient and remained on task. Teachers in Trinidad and Tobago proposed if students are educated in the proper use of utilising computers for learning, they will become more motivated to participate in curriculum activities instead of playing games. While this may be correct, it also needs to be recognised that providing students with some independent time on computers provides the students with the opportunity to self-explore how to use the technology and facilities it in more personalised and creative ways.

5.6.2 Professional development and resources.

In terms of implementing on-going structured professional development for ICT integration, a knowledgeable facilitator (MKO) is required. In addition, it should be acknowledged teachers need time to discuss and share their ideas about how they can and how they are using technology in the classroom (Bebell & O'Dwyer, 2010; Newman, King, & Carmichael, 2007). Together with professional development, teachers in Trinidad and Tobago perceived infrastructure with internet connectivity, WiFi, electrical outlets and appropriate resources were essential to encourage innovative and creative teaching and learning for the 21st Century.

5.6.3 Open repositories for best pedagogical practices.

The Director of the eConnect and Learn program and teachers suggested that an open educational repository should be established in Trinidad and Tobago to curate best practices. This resource will provide teachers with opportunities to explore teaching materials, resources, and learn about different pedagogical strategies from others. In addition, students' work/projects should reflect achievements such as value beyond the school and should be published online (Newmann, King, and Carmichael, 2007); for example, blogs set up for teachers and students to communicate about their finished tasks with others.

After four years into the eConnect and Learn program, approximately $US 53 million have been invested (Gopeesingh, 2014) for approximately 92,000 students. Although this study supports ICT integration into the Trinidad and Tobago schools, based on the interview data, the implementation could be enhanced. Long term financial strategies to help teachers' access educational technology support and resources, strengthening professional development, and constructing appropriate infrastructure have been identified as important factors that may advance the eConnect and Learn program.

The proposals made by the participants during the interview sessions in Trinidad and Tobago should be actioned by the Ministry of Education as well as the Ministry of Finance. Implementing the eConnect and Learn program was, in part, a political decision to provide laptop computers to all students in secondary schools when there was a change of government in 2010. The then Prime Minister announced at the United Nations Assembly that each child attending secondary school will own a personalised laptop computer from 2010. She envisaged the program will empower citizens of Trinidad and Tobago to "become technologically proficient, innovative and knowledge driven" (Persad-Bissessar, 2010, p. 1). In contrast, teachers in this study identified that they needed a clearer vision and framework to assist them to implement the eConnect and Learn program. As a result the LEM-LT framework described below was constructed.

5.7 Construction of LEM-LT Framework

In the Literature Review in Chapter 2 the prototype of the Learning Environment Model was illustrated in Figure 6 and discussed on pages 45 to 47. It was constructed from three dimensions: the systems level; the six design principles; and 21st Century skills. This section of the thesis builds further on the Learning Environment Model (LEM) by aligning it with the Levels of Teaching Innovation and Technological Pedagogical Content Knowledge (LT). Thus a new framework, termed LEM-LT is suggested. LEM-LT is outlined as a flow chart in Figure 24.

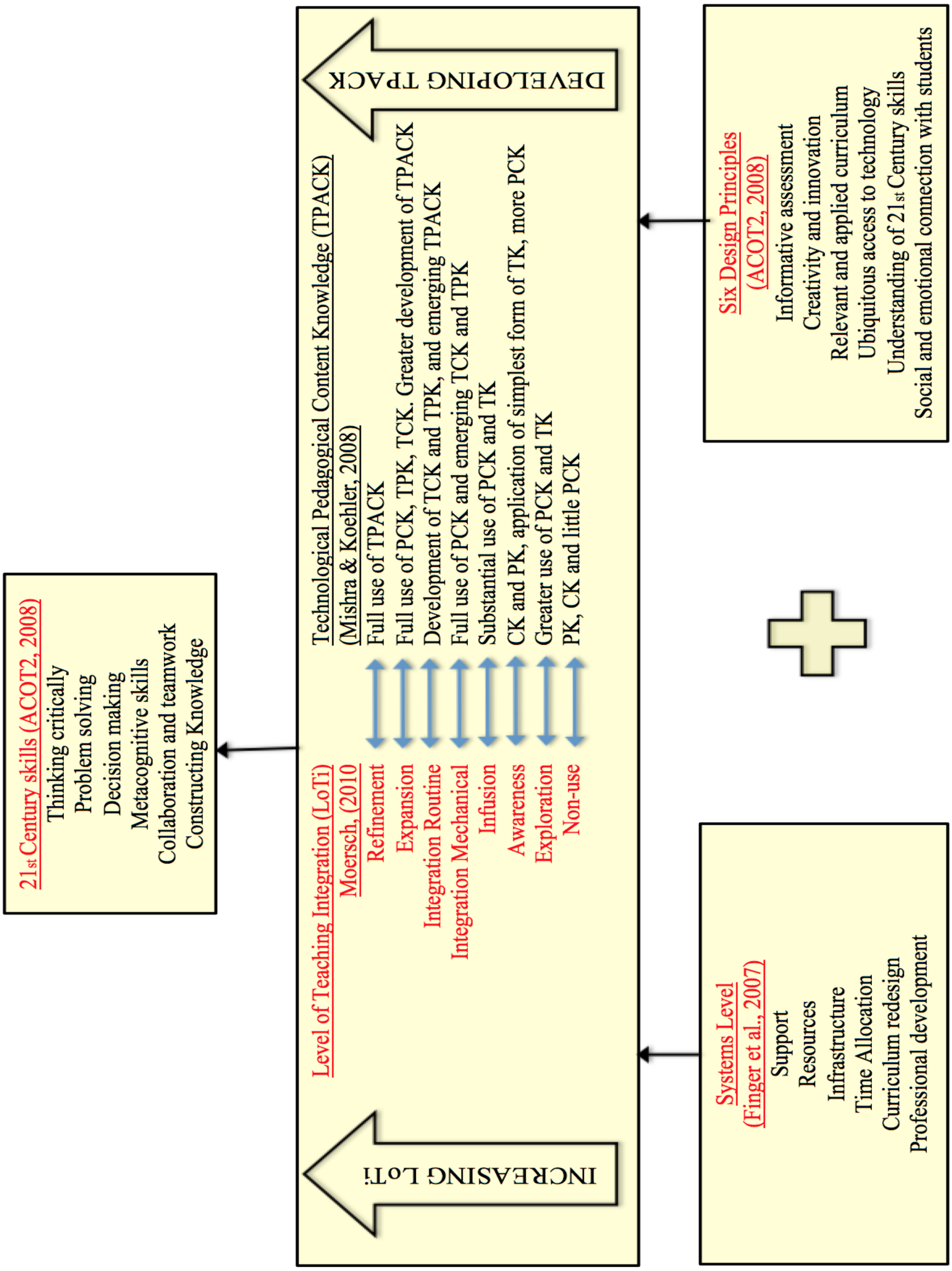

Figure 24. LEM-LT Framework
TPACK, (Mishra & Koehler, 2008); Six Design Principles, (ACOT2, 2008); Level of Teaching Innovation, (Moersch, 2010).Systems Level (Finger et al., 2007)

The LEM-LT framework was crafted from the findings and discussion from this study throughout the chapters. It contributes to additional knowledge which has the potential to guide the successful implementation of technology programs in schools. The framework presents a package (combination) of five dimensions: the systems level (Finger et al., 2007), six design principles (ACOT2, 2008), Levels of Teaching Innovation (Moersch, 2010) aligned with technological pedagogical content knowledge (Koehler, Mishra, & Yahya, 2007). These have the potential to produce the fifth dimension, 21st Century skills (ACOT2, 2008; Finger et al., 2007). This learning framework is influenced by the notion that individuals construct "new" knowledge based on their experiences and their interaction with the more knowledgeable other (MKO). The entire framework has strong theoretical underpinnings (Anderson, 2006; Engeström, 1999; Leontiev, 1978; Vygotsky, 1987) which are described in Chapter 2 on pages 47 to 50.

5.7.1 Systems level.

Change often requires systems level support and additional financial resources at the national level, if change is expected to occur at the district and school levels (AITSL, 2011; 2014). As identified previously, in terms of implementing new technology in the classroom: resources, support, infrastructure, curriculum and assessment redesign, professional development, and time allocation to practise strategies are associated with the integration of ICT instruction into classrooms (Ertmer, 1999; Finger et al., 2007; Goktas et al., 2009; Severin & Capota, 2011). Many of these variables are, in part, financially managed, distributed, and disseminated at a systems level to educational districts and schools (AITSL, 2011; 2014).

Evidence shows when these variables are made available and are disseminated and provided to teachers and schools, such as in the One-to-One computer program in Maine (Silvernail & Gritter, 2007), there is an increased likelihood that effective in-class technology programs can be implemented.

5.7.2 Six design principles.

According to the Apple Classroom of Tomorrow-Today (2008) the six design principles associated with the effective implementation of ICT into classrooms are:

- Continuous informative assessment.
- Relevant and applied curriculum.
- Culture of innovation and creativity.
- Ubiquitous access to technology.
- Understanding 21st Century skills.
- Social and emotional connection with students.

These six principles have the potential to transform the way teachers deliver instructions and create new ways for students to become more active learners with technology. Researchers in the domain of understanding the effective implementation of ICT into classrooms have also elaborated on these six design principles as outlined below:

'Continuous informative assessment' enable teachers to make informed decisions relating to readjusting instructions and curricular changes to meet the needs of students (Lei, Conway, & Zhao, 2008).

'Relevant and applied curriculum' promote 21st Century skills and prepare students according to their abilities to face the challenges of a technology-based environment and a knowledge based economy (Finger et al., 2007; Severin & Capota, 2011).

‘Culture of innovation and creativity’ acknowledges the synergy that drives today’s global economy. Innovation in technology is helping to change how people work, study, live their lives, and communicate (Cascio & Montealegre, 2015). Innovation and creativity are considered to be enhanced when students and teachers have ‘ubiquitous access to technology.’ Teachers and students alibility to create and problem solve with technology, as well as research, gather new information and facilitate social interactions and communication are enhanced (UNESCO, 2008). Teachers, students, parents and the wider community can work together on problem-based and project based learning, leveraging Web 2.0 and other digital technologies.

‘Understanding 21st Century skills’ requires teachers to organize their pedagogy and eLearning content knowledge to facilitate the ever-evolving information and technology dependent society (ACOT2, 2007)

‘Social and Emotional Connection with Students’ can help foster positive learning interactions between teachers and their students, and so create opportunities to produce a productive, vibrant, learning environment for students (Hattie 2008).

Provisions of components in the systems level, together with understanding and application of the six design principles, enable teachers to design curricular activities for enhancing students’ development of 21st Century skills. These skills are necessary for teachers and students to deconstruct and reconstruct new knowledge for the challenging information economy. According to Gaston (2009), today’s students should master traditional subjects while gaining 21st Century skills in order to succeed in the workplace of tomorrow.

5.7.3 Relationship of the Levels of Teaching Innovation and Technological Pedagogical Content Knowledge

The LT (Levels of Teaching Innovation and Technological Pedagogical Content Knowledge) component of the LEM-LT framework is an informative as well as evaluative tool for ICT integration. Moersch's (2010) Levels of Teaching Innovation and Mishra and Koehler's (2008) Technological Pedagogical Content Knowledge have the potential to inform teachers of the effectiveness of ICT integration on a continuum. The claim is that Technological Pedagogical Content Knowledge (TPACK) and the Levels of Teaching Innovation can be linked together and aligned. Both these theories contain a notion of stages from the basic to the more complex. For Mishra and Koehler, as teachers build up their confidence and skill levels, they are better able to facilitate a greater use of technology related activities in their classroom. As a result teachers are better able to adapt, modify, and incorporate eLearning to all students in the classroom. Moersch's theory also contains a stage notion and it is characterised by eight hierarchical stages: Non-use, awareness, exploration, infusion, integration mechanical and integration routine, expansion, and refinement. Other related educational notions, such as problem-based learning, value beyond the school, differentiated curriculum, authentic and relevant learning in real-time situation are, in part, embedded in both Moersch's and Mishra and Koehler's theoretical notions. These notions support the claim that after teachers and students master the basics they progress to the next stage where they learn to adapt and to generalise their new knowledge, such as the use of technology, to new situations and the wider learning and community contexts. This alignment is outlined in Table 29.

Table 29

Alignment of Levels of Teaching Innovation and TPACK

Levels of Teaching Innovation (Moersch, 2010)	Technological pedagogical content knowledge constructs (Mishra & Koehler, 2008)
Level 0: Non-Use	CK and PK and emerging PCK.
Level 1: Awareness	More PCK and emerging TK.
Level 2: Exploration	Increased PCK and greater use of TK than Level 1.
Level 3: Infusion	Substantial use of PCK and TK.
Level 4A: Integration - Mechanical	Full use of PCK and emerging TCK and TPK.
Level 4B: Integration Routine	Substantial use of TCK and TPK; and emerging TPACK.
Level 5: Expansion	Full use TPK, TCK, and substantial development of TPACK.
Level 6: Refinement	Full use of TPACK,

The claim is that this alignment of the above theoretical framework provides teachers with the opportunity to reflect on the level of ICT integration into their classroom, by reviewing the different dimensions of the Levels of Teaching Innovation and the constructs of the Technological Pedagogical Content Knowledge. For example, as teachers transition through the ‘Infusion’ stage they are likely to change their pedagogical practices associated with technology use in the classroom. It is expected that teachers are also likely to shift more to an inductive, inquiry teaching approach as their students learn to use digital tools and resources to complete a variety of learning tasks, such as using technology to design a multimedia visual production, or to use programming language to move robots around a track. At a higher stage of the Levels of Teaching Innovation, the ‘Expansion’ stage, teachers should be more confident in directing students to use the technology in a more independent and creative way. Students who are more proficient in the application of digital tools and resources are more likely to collaborate with their peers to solve problems and resolve issues. At this higher level, the teacher's Technological Pedagogical Content Knowledge is considered to include elements of: pedagogical content knowledge (PCK); technological pedagogical knowledge (TPK); and technological content knowledge (TCK). At the highest level, 'Refinement' stage, teachers technological pedagogical content knowledge, enables them to be more reflective about their teaching and students' learning (Shulman, 1987). This reflective information can also be used by teachers to make informed decisions for adjusting/redesigning curriculum activities for their students where necessary. The reflective capacity associated with higher level of teachers' technological pedagogical content knowledge could help teachers develop the confidence and capacity to utilise new and emerging technologies in their classrooms.

The entire framework, the Learning Environment Model aligned with the Levels of Teaching Innovation and Technological Pedagogical Content Knowledge (LEM-LT), has the potential to give teachers, administrators, and the wider community additional direction and vision for present and future ICT integration. Each of the five domains of LEM-LT could be monitored and evaluated separately or together on a continuous basis to better determine barriers and enablers which may propel or hinder adoption of different technology initiative and programs in schools. The framework also helps to identify the perquisite skills teachers need to advance their Levels of Teaching Innovation and their technological pedagogical content knowledge. For example, if a school wants to teach a programming language for the students to be involved with robotics, they could examine the six design levels and 21st Century skills to identify the perquisites skills which teachers and students will need to know before this initiative is introduced. In addition, the system levels can help to identify the resources and support implementation associated with maintaining this initiative over time. Also alignment of the Levels of Teaching Innovation and Technological Pedagogical Content Knowledge could aid to identify eLearning initiatives for the introduction of the programming language to students.

The linking of teachers' Levels of Teaching Innovation and their Technological Pedagogical Content Knowledge has been articulated as part of this research related to teachers' ICT use and the ICT initiative, eConnect and Learn program in Trinidad and Tobago. Even so, this alignment has the potential to be a conceptual tool that could be used by other researchers and educators when investigating ICT classroom initiatives.

5.8 Comparison of LEM-LT with other ICT frameworks

It needs to be acknowledged that the LEM-LT framework is not the only framework which has been developed to describe how teachers introduce ICT into their classrooms. Other related framework are:

- The Framework for Leading School Change in Using ICT (Newhouse, Clarkson, & Trinidad, 2005).
- The Framework for ICT in Curriculum and Assessment (NCCA) (National Council for Curriculum and Assessment [NCCA], 2007).
- Substitution Augmentation Modification Redefinition Framework (SAMR) (Puentedura, 2009).

Each of these frameworks will be briefly described below.

5.8.1 A Framework for Leading School Change in Using ICT.

The Newhouse et al. (2005) Framework for Leading School Change in Using ICT was structured around the dimension of Teacher Professional ICT attributes for teachers in Western Australia. It was used as a guide to support and promote good practice in the use of ICT for teaching and learning. Its structural framework focussed on four layers: overall outcome, components, elements, and pointers which were aligned with five hierarchical stages: inaction, investigation, application, integration and transformation. These stages were similar to the structure of Levels of Teaching Innovation in LEM-LT. For example, the lowest stage, *inaction,* corresponded to the lowest Level of Teaching Innovation, *Non-use*. The *transformation* stage was similar to the highest hierarchical level in the Levels of Teaching Innovation, *Refinement*. Although the Framework for Leading School Change in Using ICT focussed on teachers, it was positioned within five dimensions of schools' context and systems: students, learning environment attributes, teacher professional ICT attributes, school ICT capacity, and school environment. Similar to LEM-LT, the Newhouse et al. (2005) framework has a focus on teacher development and how students can achieve mastery of 21st Century technology, related competencies, knowledge, and skills.

Within the Newhouse et al. (2005) framework there are three sets of instruments for administrators and teachers to use to assess the level of ICT integration into the students' learning environment. This framework also acknowledges that teachers need time, support and resources to implement ICT innovations. The notion that time is a factor has also been identified by Darling-Hammond et al. (2005) and Roblyer (2006). The LEM-LT framework also enables teachers to assess how they are, were, and could utilise ICT in their classroom over time. The indications are that LEM-LT framework and the Newhouse et al. (2005) framework have relevance. Even so this researcher posits that the LEM-LT framework when related to the survey instruments used in this study provides teachers with opportunities to reflect on and engage with the process of ICT integration.

5.8.2 The National Council for Curriculum and Assessment (NCCA-ICT) framework.

The National Council for Curriculum and Assessment ICT framework (National Council for Curriculum and Assessment [NCCA], 2007) was the second framework which was examined in relation to the LEM-LT framework. The NCCA-ICT framework was developed in Ireland. It provided a structured approach for ICT integration in curriculum and assessment. Its foundation was constructed on four tenets which infused elements similar to the six design principles and 21st Century skills of the LEM-LT framework. The tenets were: creating, communicating and collaborating; developing foundational knowledge, skills and concepts; and understanding the social and personal impact of ICT. Each had three progressive levels corresponding to lower primary to the completion of junior cycles. This framework was used as a tool to help teachers integrate ICT purposefully and appropriately at each level for teaching and learning across curriculum subjects.

The indications were that the NCCA-ICT had a planned pedagogical framework and it provided references and resources for each learning activity for the four tenets. Opportunities were provided to teachers to collaborate and learn from others and additional resources were shared by teachers and colleagues. NCCA designed ICT activities in disciplinary and interdisciplinary areas. The LEM-LT framework is more conceptual and provides the six design principles which can be used as a guide for teachers to design their own curriculum activities for 21st Century teaching and learning. Based on the LEM-LT notions, teachers are encouraged to reflect on their practices, take charge of their curriculum planning, and seek support and resources. The main focus is to develop teachers' ICT skills so they are able to better conceptualise and organise their classroom activities according to the ICT abilities of their students. The LEM-LT model does not provide resources or lesson plans as such, but encourages teachers to use repositories, curriculum-sharing websites, sources for designing lesson plans and curriculum activities, as well as open alternatives to textbooks are available for the planning process on websites, such as, http://www.edutopia.org/open-educational-resources-guide#graph3. In addition, the Levels of Teaching Innovation section of LEM-LT enables teachers to reflect on, guide and assess their planning on a regular basis. Unlike the NCCA-ICT which is linked to the Irish school curriculum, the LEM-LT framework is not linked to any particular curriculum. As identified in the comparison between the Australian and the Trinidad and Tobago pre-service teachers, LEM-LT has flexibility; it focuses on teachers' confidence and knowledge to develop as ICT users in the school. The NCCA-ICT and the LEM-LT both have the potential to help teachers develop efficient ICT integration skills, and aim to encourage teachers to become independent planners and designers of ICT curriculum activities for their students.

5.8.3 Substitution Augmentation Modification Redefinition Framework (SAMR).

The third framework compared to LEM-LT was Substitution Augmentation Modification Redefinition (SAMR) (Puentedura, 2009). Its aim focuses on helping educators in the USA develop more effective pedagogy through technology. Elements of SAMR showed some characteristics similar to the Levels of Teaching Innovation with again a focus on teachers advancing through hierarchical levels of the use of technology within the classroom. Four hierarchical levels were outlined in the SAMR framework. Puentedura (2009) called the first two educational technology enhancement levels: *substitution* and *augmentation*. These are, in part, comparable with Moersch's (2010) Levels of Teaching Innovation: *non-use; awareness*; *exploration* and *infusion*. The other two levels Puentedura (2009) called *modification* and *redefinition.* In these two stages teachers become confident to adjust their teaching practices and their use of the technology, based on the changing needs of the curriculum and the capacity of their students to engage with technology and its related resources. These two stages are in part comparable with Moersch's (2010) *integration mechanical, integration routine, expansion,* and *refinement* levels of the Levels of Teaching Innovation. The SAMR framework and Levels of Teaching Innovation focus on teachers and their developing technology classroom practice. These attributes are contained within the LEM-LT framework which also recognises the classroom needs to be understood within a broader resource and support context. The LEM-LT model has more elements that are system focussed, such as the allocation of resources, the input of new support to the teacher and the school, and the need for the school to be serviced by ICT infrastructure. In addition LEM-LT demonstrates teachers should be provided with the time and professional development to enhance their proficiency, competence with technology, and digital learning resources and practices.

5.8.4 Summary of the comparison of LEM-LT with three ICT frameworks.

LEM-LT was compared with three frameworks to investigate alternative models for advancing technology integration into the classroom. The other three models are: the Framework for Leading School Change in Using ICT (Newhouse, Clarkson, &

Trinidad, 2005); the Framework for ICT in Curriculum and Assessment (NCCA) (National Council for Curriculum and Assessment [NCCA], 2007); and the Substitution Augmentation Modification Redefinition Framework (SAMR) (Puentedura, 2009).

All four frameworks suggest that teachers' ICT development of skills and capacity to integrate technology into their classroom can be plotted on some form of hierarchical structure. They also support the notion that while teachers may adopt different forms of technology and digital resources, teachers typically go through a period of uncertainty, overcoming challenges along a continuum before full implementation of the new technology into the classroom. Compared to the other three frameworks, LEM-LT has more of a systems level focus, with a recognition that resources and support from outside the classroom are necessary to facilitate teachers' pedagogical practices with ICT in the classroom. The LEM-LT is also somewhat stronger than the other three models in articulating its theoretical underpinnings with the inclusion of the six design principles.

5.9 Limitations

It is acknowledged there were limitations to this study. An understanding of the limitation could shape and frame future studies. Therefore, the attributes of each limitation are discussed in relation to the present study as well as their contribution to future studies.

The core aim of this research was to investigate the teachers' perceptions of Trinidad and Tobago eConnect and Learn program in alignment with the Trinidad and Tobago teachers' technological pedagogical content knowledge. It is likely that those students who received the free laptop computers and their families may have very different perceptions about the value of the eConnect and Learn program to those of the teachers. This focus on the teachers is a limitation of this research. To address this limitation, future researchers could follow up on those students who received these computers and investigate the question: How did the eConnect and Learn program affect the students' education? Similarly, a related future research question to be investigated could be: Did the availability of a home and school laptop computer assisted the parents to connect with their children's schooling?

Data collected from participants for the interview sessions included pre-service and in-service teachers, ICT technicians, school supervisors, and the Director of the eConnect and Learn program. Principals, parents, and students' voices were absent from the interview session. Their input could have contributed information from different perspectives and angles of the use of the eConnect and Learn program. Analyses of their data would have been important to triangulate the findings provided by participants' results, thus contributing to a more robust study. The data were collected at a particular point in time, with the Trinidad and Tobago government funding an initiative to encourage all high school students to become more computer and technology literate. The eConnect and Learn initiative was the focus of this research, but it needs to be acknowledged that there may be other initiatives that were not investigated that may also be making a contributions to teachers' knowledge in terms of enhancing their confidence and competence to integrate technology into their teaching practices. For example, the University of Trinidad and Tobago is making a commitment to include more eLearning into their teacher education program. The indications are that the Trinidad and Tobago school curricula are also being adapted to encourage greater use of eLearning in the classroom. These initiatives are also worthy of investigation.

This study focussed on teachers' self-reported ratings on their in-class behaviour and attitudes related to technology use, as well as interview data. While not questioning the accuracy of these self-report surveys, self-reports have their limitations. Additional methods could be considered to investigate teachers' in-class utilisation of technology. For example, analysing videoed lessons where the teachers incorporate technology in the classroom may provide additional information on how effective teachers were integrating technology in their teaching.

Analysis of variance explored the impact of teaching experience and school category on teachers' TK, TPK/TCK, and TPACK scores. School category included only denominational and government schools. Exploring the impact of single gender schools and co-educational schools on teachers' TK, TPK/TCK, and TPACK would have widened the scope of the study. Inferences could have possibly been made of cultural and diverse use of ICT in the different school types.

Standard scores (*Z* scores) were computed on the basis of mean TPACK scores collected from Australian pre-service teachers in 2011 and from Trinidad and Tobago pre-service teachers in 2013. It is acknowledged that it is difficult to truly compare what look like two similar cohorts of pre-service teachers from two educational systems from two very different countries, using survey instruments. It is acknowledged that other factors are also likely to help or hinder the pre-service teachers' level of digital and technology knowledge and confidence, such as limited access to available infrastructure to support technology use, particularly in rural and economically poorer regions of Trinidad and Tobago. That is, the in-service and pre-service teachers may have been willing to use more technology in their schools, but access to that technology has been and is still limited. Furthermore, factors other than those identified in this research outside the control of the Trinidad and Tobago teachers may be having an impact on their attitudes towards and use of technology in their classroom. Even so, given the expectation that the TPACK instrument continues to be used to gauge teachers' level of confidence and knowledge of technology use in the classroom, there is potential to do additional research on how different cohorts of teachers respond to the TPACK instrument in different settings and over time.

5.10 Summary of Chapter 5

Findings from a mixed methods research were discussed in relation to the eight research questions as outlined in the study. The Trinidad and Tobago pre-service teachers were more confident to integrate ICT in their pedagogical content practices than in-service teachers. This difference could be attributed to newer teachers growing up in a more technologically infused social and communication environment than the older teachers and/or their university program of teacher education was more supportive of eLearning, than previously. Support for the social environment factor also originates from the finding that teachers who had less than 10 years of teaching experience and were recent graduates from the University were more confident in ICT integration, than the in-service teachers who had more than 10 years of teaching experience. At the international level, pre-service teachers from Trinidad and Tobago and Australia had a high level of consistency for confidence to use ICT and support their students' use of ICT.

The evidence, particularly from the interview data, reveals full utilisation of the eConnect and Learn program has not yet taken place. The suggested reasons for this focused on issues associated with: inadequate infrastructure in the learning environment; sparse professional development; and time allocation for teachers to practice and reflect on their pedagogical practices with technology.

Trinidad and Tobago was not the only country to experience a slow adaptation of teachers' pedagogical practices with technology. Similar experiences have been documented by other researchers (Bate et al., 2012; Drayton et al., 2010; Lei, 2010). In spite of the slow diffusion, teachers were willing to advance the eConnect and Learn program. They bought their own computers, scanners, printers and LCD projectors and some were involved with school based and web based information and informal discussion about how to advance their pedagogical practices with technology.

The Trinidad and Tobago Ministry of Education (2010) hoped that the eConnect and Learn program would help teachers to develop an ICT framework that would enhance, broaden, strengthen and transform learning through a greater use of eLearning in the classroom (MOE, 2010a). To help guide the future implementation and diffusion of technology programs in Trinidad and Tobago and elsewhere, this thesis proposed a conceptual framework, LEM-LT, see Figure 24. This framework has the potential to provide more direction and more defined vision to inform, monitor and evaluate teachers' practices as they further integrate the eConnect and Learn program and similar programs into their pedagogical practices with technology.

How teachers use the framework will reflect provisions made at the systems level, such as professional development, resources and infrastructure. Professional development should include an understanding of teachers use of the six design principles (ACOT2, 2008) to develop 21st Century skills for their students. In addition, this study supports the notion that teachers need to be better informed about the application of TPACK and its content to help the teachers reflect on their pedagogical practices with technology (Mishra & Koehler, 2008). This reflection can help teachers to negotiate how to select the appropriate technology for their pedagogical practices in their dissemination of concepts and curriculum activities to the students in the classrooms. The Levels of Technology Innovation framework should be explained to teachers as an informative and an analytical tool for teachers to review their ICT integration. In addition, time should be allotted for teachers to have greater collaboration with other teachers and those individuals with greater technological expertise. This collaboration has the focus of assisting teachers in the development of "best practices" in a particular content area and their use of eLearning strategies and digital resources.

It is acknowledged that the adoption of the LEM-LT framework or simular framework is dependent on teachers' willingness to accept and organize their teaching and learning in somewhat different ways. The effective implementation and diffusion of the LEM-LT framework is acknowledged as a multifaceted, complex process that is underpinned by factors, such as teachers' competencies and the schools' readiness and resources (Govender & Dhurup, 2014). In essence the LEM-TL framework tries to encapsulate some of the core elements identified in the research literature on implementing effective pedagogical practices and the integration of ICT across the curriculum.

CHAPTER 6: CONCLUSION

6.1 Introduction

This research project was initiated as a result of the eConnect and Learn program which was introduced in Trinidad and Tobago in 2010. The program provided free personalised laptop computers for all students transitioning from primary schools to secondary schools. By 2013 it was an opportune time to investigate how teachers were integrating the laptop computers and their related devices in the learning environment. Previous research literature revealed technological knowledge alone cannot produce the skills required for teaching and learning with ICT for the 21st Century. Technological knowledge (TK) should be manipulated and dynamically woven with pedagogical knowledge (PK) and content knowledge (CK) (Finger et al., 2007; Mishra & Koehler, 2009; Niess, 2005) for teachers to develop the confidence to integrate ICT successfully. The end products of this transaction resulted in pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK).

Although other researchers have reviewed these processes, challenges still existed with the understanding of the relationships of these domains and their factor structure in survey instruments (Angeli & Valanides, 2009; Archambault & Barnett, 2010; Chai et al., 2010; Lee & Tsai, 2010; Liang et al., 2013; Jaikaran-Doe & Doe, 2016). In addition, uncertainty existed among teachers in relation to appropriate ways to reflect on their levels of ICT integration for their pedagogical practices and students' learning. To fill these gaps, eight research questions were investigated.

This chapter presents a summary of the research project. It proceeds with a brief discussion of the main findings in relation to each of the research question. The significance and future research are discussed. The implications of the research are examined with appropriate proposals to better improve teachers and students' ICT integration. Finally, this chapter concludes with the importance of the LEM-LT framework as a guide for teachers and the Ministry of Education to better propel the eConnect and Learn program into the future.

6.2 Summary of Key Findings

Research Question 1: *Based on teachers' survey results, what is the relationship between their TK, TPK/TCK, and TPACK scores?*

There was a strong positive linear relationship between each set of variables. The relationship hypothesised as teachers' confidence increase in their technological knowledge (TK), there was a corresponding increase in their technological pedagogical knowledge/technological content knowledge and technological pedagogical content knowledge. Pre-service teachers and recent graduates of the University of Trinidad and Tobago acquired deeper knowledge of ICT integration as compared with in-service teachers.

Research Question 2: *How confident are pre-service and in-service teachers to use ICT as determined by the TK, TPK/TCK and TPACK surveys?*

The results from individual samples *t*-tests for each scale of the surveys revealed pre-service teachers had higher mean scores than in-service teachers for all the items. This indicated pre-service teachers were better able to manipulate their technological knowledge with their pedagogical and content knowledge and therefore acquired deeper knowledge in ICT integration than in-service teachers. Most likely in-service teachers were engaged in integrating their pedagogical knowledge for planning daily curriculum activities in disciplinary and interdisciplinary areas. Analysis of data highlighted in-service teachers' ICT performance was affected by a lack of available access to resources, appropriate infrastructure, time to practice what was learned, and collaboration among their peers. Some teachers bought their own technological resources to help integrate ICT in their classes.

Research Questions 3: *Do teaching experience and school category impact upon teachers' TK, TPK/TCK, and TPACK scores respectively?*

School category had no significant impact on the scores. Teachers with less than 10 years of teaching experience were more positive about using ICT in the classrooms. The indications are teachers who have completed Educational Technology and Instructional Design courses were associated with deeper ICT integration knowledge.

Research Questions 4: *Do instructional content areas and qualifications impact upon teachers' TK, TPK/TCK, and TPACK scores?*

Results from the MANOVA reported pre-service teachers who were not yet qualified with an undergraduate degree obtained higher mean scores for TK, TPK/TCK, and TPACK in Mathematics, Science and Humanities than in-service teachers. Instructional content areas did not impact on the scores. These results were most likely attributed to the structural organisation of teacher certification and employment in secondary schools. In-service teachers were employed with an academic degree with or without teacher education.

Research Question 5: *What are the factor structures for the teacher surveys?*

The results for Research Question 5 demonstrated strong internal consistency in the surveys (α)TK =.94; (α)TPK/TCK = .98; and (α)TPACK = .98. The interpretation of one factor solution for TPK/TCK and another for TPACK in the Trinidad and Tobago study was generally consistent with the findings of previous researchers in the Teaching Teachers for the Future (TTF) project in Australia (Jamieson-Proctor et al., 2013). The one factor solution for the Trinidad and Tobago TK survey was labelled 'confidence to use ICT'; for TPK/TCK survey the one factor solution was labelled "professional practice and pedagogy for supporting teaching" and finally for TPACK survey, it was labelled "support for student learning with ICT".

Research Questions 6: *What is the comparison of pre-service teachers' TPACK scores from Australia and Trinidad and Tobago?*

An examination of the results indicated there was a significant difference for six items of the TPACK survey. Australian pre-service teachers obtained higher mean scores for six items whereas Trinidad and Tobago pre-service teachers had higher mean score for one item. There was a high level of consistency for confidence to use ICT and to support students' use of ICT for 14 items for the two cohorts. Both cohorts pursued a Bachelor in Education at their respective university.

Research Questions 7: *Can Moersch's (2010) Levels of Teaching Innovation be used to review and interpret teachers' interview data relating to pedagogical practices with computers and related devices?*

The eight stages of Moersch's (2010) Levels of Teaching Innovation were central to review and interpret Trinidad and Tobago in-service teachers' interview data in relation to their pedagogical practices with computers and related devices. Results for the analysis of in-service teachers' interview indicated three teachers (6%) were at the Moersch's Non-Use Level (Level 0). There was an absence of technology integration for pedagogical practices or delivery of instruction. The highest number of responses for integration of ICT was at Level 1, the Awareness Level with 43% of the teachers exhibiting only technological knowledge. This suggested teachers were most confident to use the simplistic form of computers and related devices to embellish teacher-directed instruction. A total of 18% of the responses of how teachers integrate ICT with computers and related devices were at the Exploration Level; 16% were at the Infusion level; and 12 % were at the Integration Mechanical level. There was one response each for the Integration Routine, Expansion, and Refinement levels. These results provided insights into the implementation of the eConnect and Learn program. The evidence shows that the Trinidad and Tobago teachers were operating at the lower Levels of Teaching Innovation.

Research Question 8: *What implications are there for the future of the eConnect and Learn program in Trinidad and Tobago?*

The implications for the future of the eConnect and Learn program was explored by analyses of the interview data in relation to participants' experiences of the program. Proposals were made by the teachers to bridge the gap between the knowledge they sought to integrate ICT and the provisions made by administrators and the Ministry of Education. Enhanced professional training, supported by available resources and appropriate infrastructure could contribute to develop the confidence, skills and abilities teachers need to promote the use of the eConnect and Learn program. Concerns for students were identified from two different perspectives: the over reliance on the Government to provide resources and the need for continuous education to utilise new and emerging technologies. Both were important because the former has the potential to uplift students' appreciation and value their laptop computers whereas the latter will give them the drive to become more engaged with curriculum activities.

6.3 Significance of the Study

This study contributes to the corpus of literature relating to teachers' ICT integration and their technological pedagogical content practices in their classrooms. The study's findings are generally supportive of previous research on teachers' technological pedagogical content knowledge as conducted by Finger et al. (2010); Kay (2006); Swain (2006); and Tersptra (2010). This research project has adopted Moersch's (2010) Levels of Teaching Innovation as a method to review and interpret the interview data associated with implementation the eConnect and Learn program. In addition, the posited LEM-LT framework aims to bring together five important dimensions which can help frame teachers' pedagogical practices for 21st Century learning environment. The framework also has the potential to encourage students to use digital devices and resources in the home, school, work place and community.

The findings of this research project have implications for the policy makers of the Ministry of Education, principals, and teachers of Trinidad and Tobago. This study maintains that while providing laptop computers to high school students may be considered a necessary first step to enhancing eLearning in the classroom, it is not sufficient. In particular, teachers' pedagogical content knowledge related to the integration of technology into the classroom is a much more complex and resource dependent process than what was initially envisioned by those who implemented the eConnect and Learn program.

6.4 Implications of this study

Secondary school teachers articulated they wanted, "not only training to one or two teachers in each school but to all teachers." The teachers wanted to become more knowledgeable about how to integrate the laptop computers and related devices provided by the eConnect and Learn program for their teaching and students' learning. Based on statistical analyses in this study, pre-service teachers were more confident than in-service teachers in ICT integration for the dissemination of content. Furthermore, teachers who had recently entered the teaching profession were more knowledgeable and confident in ICT integration than teachers who were employed for more than 10 years in secondary schools in Trinidad and Tobago. One participant articulated, “there are lots of older teachers who are not IT competent.” To bridge this technological gap the following proposals are made:

- *Teaching practicum:* During teaching practicum, pre-service teachers can model how to integrate appropriate technologies in the delivery of curriculum activities for in-service teachers (Fluck, 2007).
- *More knowledgeable other (MKO):* Principals should encourage ICT integration workshops, and seminars in specific disciplines, interdisciplinary, and multidisciplinary areas with a MKO (Vygotsky, 1978). This term is referred here to teachers who are recent graduates with a teaching degree and are employed in secondary schools. Internal workshops should encourage and inspire less confident and reluctant teachers to become more motivated in the application of ICT integration in their discipline areas. Communication on challenges encountered can be readily achieved since both cohorts are employed in the same school.
- *Online learning:* Online learning is a platform for professional development. This mode of learning has the potential to influence teachers to become independent learners for productive ICT integration. Principals and the Ministry of Education could encourage teachers to participate in webinars, Massive Online Open Courses (MOOC), and access open education resources (OERs) related to ICT integration. A MOOC provides a platform for interactive user forums to support interactions between teachers and presenters. Free courses are provided by universities in many disciplines (https://www.edx.org). OERs such as Khan Academy (https://www.khanacademy.org/) contain lesson plans illustrating appropriate teaching methods with resources for ICT integration in specific

disciplines. Teachers can also curate and publish their lesson plans as well as their students' work/projects.

- *National and international conferences:* Financial allowance should be provided to encourage teachers to attend national and international ICT conferences. Opportunities should be provided for teachers to share their experiences and to gain insights into innovative approaches with new and emerging technologies.
- *Motivation:* Principals and Heads of Department should give special recognition to teachers when they complete seminars, workshops, and online education for ICT integration. This may further motivate and inspire other teachers to participate in similar ICT activities.

6.4.1 Time allocation.

Professional learning does not necessarily guarantee successful ICT integration (Cox, Preston, & Cox, 1999) nor does it necessarily enhance the quality of learning outcomes for students (Fitzallen & Brown, 2006) unless it is routinely practiced on a regular basis. Therefore the following proposals are made:

- *Structured time:* Principals should arrange specific time for teachers to share and practice skills, knowledge, and concepts accessed at professional development seminars, workshops, online learning, and conferences.
- *Ongoing practice:* Time allocated to practice what was learned should be ongoing so that teachers will have the opportunity to develop not only surface knowledge, but also deep understanding (Biggs & Tang, 2011) of how to successfully integrate computers and related devices for teaching and student learning.

6.4.2 Implication for theory.

Successful implementation (Hall & Hord, 1987; Rogers, 1993) of the eConnect and Learn program will be determined by the frequency and effectiveness with which teachers and students utilise computers and related devices for curriculum activities. For this to happen, teachers and students need to move from Technology Literacy level to Knowledge Deepening and finally to Knowledge Creation (UNESCO, 2008). This in turn requires more policy review and even curriculum changes to support the inclusion of digital and eLearning in the classroom. In addition, decision making processes, trust, available finance for resources, and timely technical assistance are also recommended to speed up the implementation of the eConnect and Learn program.

- *Policy implementation:* The Trinidad and Tobago Ministry of Education should implement the factors imbedded in the eConnect and Learn policy (Gopeesingh, 2010a) and the ICT Professional Development Implementation Plan for Educators (MOE, 2012). Appropriate resources are very important to transform learning in creative and innovative ways. Each teacher should be given a free personalised laptop computer similar to those distributed to each student transitioning to secondary schools. Internet connectivity in the entire school promotes access to valuable information for research and project based learning. Furthermore, an ICT team in each school could review, plan, monitor and evaluate the progress of ICT integration within a school. Peer student learning in terms of technology use could be encouraged. For example, a cadre of students with knowledge of the functionalities of computers and related devices could be used to assist their peers and teachers if technological problems are encountered in the school.
- *Decision making:* Decisions related to the eConnect and Learn program and ICT integration for teaching and learning could be enhanced with more consultation

with the Trinidad and Tobago Ministry of Education officials and between principals, teachers, parents, and students who have a shared vision of the program.

- *Trust:* Principals and Heads of Department should encourage teachers to use the facilities in the school to enhance efficiency in teaching and learning. This encouragement may involve teachers experimenting with how they use eLearning products and resources within their classroom. Work stations should be positioned with all the necessary resources such as teaching materials, photocopying machines, and printers for easy access. These resources will contribute to better preparation of tasks and delivery of instructional materials, thus increasing the implementation rate of the eConnect and Learn program.
- *Costs:* School administrators in association with the Ministry of Education should negotiate with wholesalers and financially invest wisely to purchase high quality technological resources such as computers and related devices at the lowest prices. Possibly money saved can be invested to support a reduction in first order barriers (Ertmer, 1999) such as purchase of resources, installation of appropriate infrastructure and maintenance of computers.
- *Technical assistance:* Currently only one ICT technician is assigned to a secondary school and five primary schools. An online helpdesk offering technical assistance to teachers and students will alleviate the technician's workload and facilitate the resolution of computer problems in a timely manner.

6.4.3 Curriculum adaptation.

The findings of this study revealed teachers' competencies with computers and related devices occurred between the Awareness level and the Infusion level of

Moersch's (2010) Levels of Teaching Innovation. The Awareness level demonstrated the application of primarily technological knowledge whereas the Infusion level reflected the commencement of a constructivist approach. Implications of these were discussed and suggestions were made to guide teachers how to develop appropriate technological pedagogical content knowledge to reach the Refinement level of Moersch's (2010) Levels of Teaching Innovation.

- *21st Century skills***:** The exponential spread of new and emerging digital technologies has led to an expectation of a revolutionary wave for improvement to pedagogy and learning. Therefore, principals and teachers need to readjust the curriculum according to students' abilities to face the challenges of the 21st Century technology-based environment and the knowledge based economy. Computational thinking and information systems need to be incorporated into the curriculum so that students will develop the abilities, skills, and knowledge to define, design, and implement digital solutions. Adaptation of the curriculum to facilitate these areas can motivate teachers to construct blogs, Wiki, Scratch, coding, solve problems and gain new knowledge of programing skills.
- *Application of LEM-LT framework:* Teachers should make use of the components of the LEM-LT framework which include the systems level, the six design principles, and the alignment of the Levels of Teaching Innovation with technological pedagogical content knowledge (TPACK). Understanding these components and applying them to everyday teaching and learning will support teachers to develop 21st Century skills for teaching and students' learning.

6.5 Future Research

The findings from this research have provided important relevant suggestions related to the eConnect and Learn program. Principals, school supervisors, and the Trinidad and Tobago Ministry of Education (MOE) could use the study's findings to refine future implementation of the program. In addition, the information produced by this research can be used as baseline data by the MOE to initiate further evidence-based evaluation (Hattie, 2008; Williams et al., 2000). Based on the findings, the MOE in collaboration with the Director of the eConnect and Learn program could consider developing policies for future refinement and extension of the program.

The LEM-LT framework could be further considered in Trinidad and Tobago, and in a wider context, such as neighbouring Caribbean countries and Latin America. Findings obtained can be analysed and changes can be made where necessary to strengthen and further validate the LEM-LT framework. This framework has the potential to be used as an informative tool as well as an assessment tool for teaching and learning a range of eLearning initiatives in different countries.

6.6 Concluding Comments for Chapter 6

As stated at the start of this study this research is supportive of the initiative to provide a computer to each high school student, particularly in a country like Trinidad and Tobago which has significant pockets of both rural and urban poverty (United Nations Development Program, 2013). Such poverty would prevent many families and schools from affording a school and home computer to assist the Trinidad and Tobago students' education. In particular, providing students with open access to technology via a laptop computer has the potential to facilitate 21st Century learning for all students (ACOT2, 2008). This study is of particular relevance to Trinidad and Tobago because policy makers from the Ministry of Education maintained that their ICT framework could be designed to enhance, broaden, strengthen and transform learning for all students. To guide the future implementation of technology programs, this thesis has proposed the LEM-LT framework. The five dimensions in the framework provide direction and a possible vision to inform, monitor, and evaluate teachers' performance as they advance the eConnect and Learn program as well as similar initiatives.

New and emerging digital technologies are likely to become more multifaceted, sophisticated, and complex (for example, the use of programming language in the classroom). The ongoing development of the global 21st Century knowledge, digital and interconnected economies requires individuals with both general and specific technology skills. Educating those individuals with these skills places an increased responsibility on all teachers to be effective and competent users and demonstrators of technology in the classroom. This study has elaborated on this responsibility and on teachers' capacity to adopt a higher level of technological pedagogical content knowledge. Developing and maintaining teachers' technological pedagogical practices needs to be encouraged and supported.

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APPENDICES

Appendix A: Ethics Approvals

Social Science Ethics Officer
Private Bag 01 Hobart
Tasmania 7001 Australia
Tel: (03) 6226 2763
Fax: (03) 6226 7148
Katherine.Shaw@utas.edu.au

HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

UTAS

28 June 2013

Professor Ian Hay
Faculty of Education
Locked Bag 1308

Student Researcher: Seeta Jaikaran-Doe

Sent via email

Dear Professor Hay

Re: MINIMAL RISK ETHICS APPLICATION APPROVAL
Ethics Ref: **H0013354 - Investigating the levels of secondary school teachers' technological pedagogical content knowledge (TPACK) in the implementation of information and communications technology (ICT) for Grade 6-9 students in Trinidad and Tobago**

We are pleased to advise that acting on a mandate from the Tasmania Social Sciences HREC, the Chair of the committee considered and approved the above project on 27 June 2013.

This approval constitutes ethical clearance by the Tasmania Social Sciences Human Research Ethics Committee. The decision and authority to commence the associated research may be dependent on factors beyond the remit of the ethics review process. For example, your research may need ethics clearance from other organisations or review by your research governance coordinator or Head of Department. It is your responsibility to find out if the approval of other bodies or authorities is required. It is recommended that the proposed research should not commence until you have satisfied these requirements.

Please note that this approval is for four years and is conditional upon receipt of an annual Progress Report. Ethics approval for this project will lapse if a Progress Report is not submitted.

The following conditions apply to this approval. Failure to abide by these conditions may result in suspension or discontinuation of approval.

1. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval, to ensure the project is conducted as approved by the Ethics

Committee, and to notify the Committee if any investigators are added to, or cease involvement with, the project.

2. Complaints: If any complaints are received or ethical issues arise during the course of the project, investigators should advise the Executive Officer of the Ethics Committee on 03 6226 7479 or human.ethics@utas.edu.au.

3. Incidents or adverse effects: Investigators should notify the Ethics Committee immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.

4. Amendments to Project: Modifications to the project must not proceed until approval is obtained from the Ethics Committee. Please submit an Amendment Form (available on our website) to notify the Ethics Committee of the proposed modifications.

5. Annual Report: Continued approval for this project is dependent on the submission of a Progress Report by the anniversary date of your approval. You will be sent a courtesy reminder closer to this date. **Failure to submit a Progress Report will mean that ethics approval for this project will lapse.**

6. Final Report: A Final Report and a copy of any published material arising from the project, either in full or abstract, must be provided at the end of the project.

Yours sincerely

Katherine Shaw
Ethics Officer
Tasmania Social Sciences HREC

Social Science Ethics Officer
Private Bag 01 Hobart
Tasmania 7001 Australia
Tel: (03) 6226 2763
Fax: (03) 6226 7148
Human.ethics@utas.edu.au

HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

UTAS

20 September 2013

Professor Ian Hay
Faculty of Education
Locked Bag 1308

Sent via email

Dear Professor Hay

Re: APPROVAL FOR AMENDMENT TO CURRENT PROJECT
Ethics Ref: **H0013354 - Investigating the levels of secondary school teachers' technological pedagogical content knowledge (TPACK) in the implementation of information and communications technology (ICT) for Grade 6-9 students in Trinidad and Tobago**

- Addition of co-investigator Dr Andrew Fluck.
- Amendment to extend the research to two other groups of participants in Trinidad and Tobago: Pre-service final year secondary school teachers (N=50) and School Supervisors (N=8).
- Information sheet and interview questions for pre-service teachers.
- Information sheet and interview questions for school supervisors.

We are pleased to advise that the Chair of the Tasmania Social Sciences Human Research Ethics Committee approved the Amendment to the above project on 18 September 2013.

Yours sincerely

Katherine Shaw
Ethics Officer
Tasmania Social Sciences HREC

Social Science Ethics Officer
Private Bag 01 Hobart
Tasmania 7001 Australia
Tel: (03) 6226 2763
Fax: (03) 6226 7148
Human.ethics@utas.edu.au

HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

UTAS

29 October 2014

Dr Andrew Fluck
Faculty of Education
Locked Bag 1307

Sent via email

Dear Dr Fluck

Re: APPROVAL FOR AMENDMENT TO CURRENT PROJECT
Ethics Ref: **H0013354 - To what extent does the eCAL (e-Connect and Learn) program influence the development of technological pedagogical content knowledge (TPACK) of in-service and pre-service teachers in Trinidad and Tobago?**

1. Change of title to 'To what extent does the eCAL (e-Connect and Learn) program influence the development of technological pedagogical content knowledge (TPACK) of in-service and pre-service teachers in Trinidad and Tobago?'
2. Change of chief investigator from Prof Ian Hay to Dr Andrew Fluck.
3. Request to use data collected from five ICT technicians and the Director of the eCAL program from Trinidad and Tobago for the dissertation.
4. Information Sheet and Consent Form for retrospective permission.

We are pleased to advise that the Chair of the Tasmania Social Sciences Human Research Ethics Committee approved the Amendment to the above project on 28 October 2014.

Yours sincerely

Katherine Shaw
Executive Officer
Tasmania Social Sciences HREC

Approvals from Trinidad and Tobago

MINISTRY OF EDUCATION
EDUCATIONAL PLANNING DIVISION
CHEPSTOW HOUSE, 56 FREDERICK STREET, PORT-OF-SPAIN
TEL/FAX: 625-0806

September 30th 2013

Locked Bag
1308 Launceston Tasmania 7250
Australia
Seetam@utas.edu.au

Dear Ms. Seeta Jaikaran-Doe,

Your request to conduct research on **"Evaluation of Secondary School's Technology Programme in Trinidad and Tobago"** has been approved.

Attached is a letter of confidentiality, which is to be completed by the person conducting research through the Ministry and returned to the Educational Planning Division of the Ministry of Education.

Yours Respectfully,

Mrs. Lenor Baptiste-Simmons
Director
Educational Planning Division
Ministry of Education

Declaration to Ministry of Education

MINISTRY OF EDUCATION
EDUCATIONAL PLANNING DIVISION
CHEPSTOW HOUSE, 56 FREDRICK STREET
PORT OF SPAIN, TRINIDAD & TOBAGO

I, ..SEETA....JAIKARAN-DOE.................... of THE UNIVERSITY of TASMANIA (Association, N.G.O., School/University) solemnly and sincerely affirm and declare that:

1. I will conduct research only in accordance with the approval granted by the Ministry of Education.
2. I will not, without due authority of the Ministry of Education in any manner whatsoever, publish or communicate any facts of information acquired during the course of my study / research or programs implemented by my organization / association.
3. I must treat with the strictest confidence all information that I obtain during the course of my research / study or programme implementation.
4. That a copy of all data so retrieved must be stored in full with the Ministry of Education whether published or not.

(Signed) ... .
Declarant

Declared before me this ....1st................ day of ....October.......... 20.13.

(Signed) ...

Appendix B: Letter to Principals

University of Tasmania
Faculty of Education
Sandy Bay TAS7005
Australia

The Principal,

______________________,

______________________.

September 23, 2013.

Dear __________________,

The Ministry of Education has granted permission for me to conduct a research project at your school from September 23, 2013 to December, 2013. Currently I have written to the ______________________________ seeking its permission for your school to participate in the study. The research focuses on the technology program that began in 2010 at your school and attempts to understand how your teachers integrate ICT in their pedagogical practices and delivery of curriculum goals and objectives. This research activity consists of two parts: A survey section and an interview. Each will take less than thirty minutes to complete.

I am looking for interested teachers, such as your members of staff to participate in this project. I would like to make an appointment with you to discuss the project further and to work out the best possible way to conduct this research at your school. Any support and input you can contribute will be highly appreciated.

I shall be very grateful for any advice you can give for the successful implementation of this project at your school.

Kind regards,

Seeta Jaikaran-Doe.

seetam@utas.edu.au

761-6211

Appendix C: Information Letter and Consent Form

TEACHER INFORMATION SHEET

Locked Bag 1304 Launceston
Tasmania 7250, Australia
Phone (03) 6324 3144
www.utas.edu.au/educ

Information for participants

Title: Investigating the impact of laptop computers on teachers' pedagogical practices in Trinidad and Tobago.

Invitation

I, Seeta Jaikaran-Doe, invite you to be involved in this study which is of national significance in Trinidad and Tobago. The study focuses on the evaluation of how teachers are integrating the free laptop computers across the curriculum. Your contribution will provide important information which can help to make informed decisions to better guide the execution of the program in the future.

The research is conducted in partial fulfilment of a PhD Degree under the supervision of Dr. Andrew Fluck, Professor Ian Hay and Dr. David Moltow in the Faculty of Education.

What is the purpose of this study?

The purpose of this study is to investigate teachers' integration of the eConnect and Learn program across curriculum areas and to evaluate the stage the program has reached.

Why have I been invited to participate?

You are eligible to participate in this study because you are directly involved in the eConnect and Learn program.
Please note that your involvement in this study is voluntary and there will be no consequence if you decide to withdraw at any time. Your relationship with the Ministry of Education or the University of Tasmania will not be affected. You can also ask for your materials, such as the recording of the interview to be removed from the project. Your right to do so will be respected.

What will I be asked to do?

You will be asked to participate in a survey and/ or an interview. Please note the survey is not done online because some teachers may not have access to the internet. If you agree then you will be asked to sign a consent form giving informed consent to participate in the study.

Are there any possible benefits from participation in this study?

Your participation in this study will provide the opportunity to reflect on the different ways ICT is integrated in pedagogical practices for teaching and learning.
You participation will help to explore the adoption stage of the eConnect and Learn program.

Are there any possible risks from participation in this study?

I do not foresee any risks from participation in this study, but please let us know if you have any concern.

What if I change my mind during or after the study?

Although I would be pleased to have your participation, I respect your right to decline. There will be no consequences to you if you decide not to take part. All information will be treated in a confidential manner, and neither your name nor any other identifying information will be used in any publications arising from the project.

What if I have questions about this study?

If you have any questions about this study, please feel free to contact the researcher at seetam@utas.edu.au or phone + 61 3 6225 5237 or 655 2746/723 7802.
"This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Ethics reference number H0013354.

Thank you for taking the time to consider this study.

If you wish to take part in the study, please sign the attached consent form.
The information sheet is for you to keep.

Consent Form

Locked Bag 1304 Launceston
Tasmania 7250, Australia
Phone (03) 6324 3144
www.utas.edu.au/educ

Title: Investigating the impact of laptop computers on teachers' pedagogical practices in Trinidad and Tobago.

1. I have read and understood the 'Information Sheet' for this project.
2. The nature and possible effects of the study have been explained to me.
3. I understand that the study involves survey and/or interviews and will be conducted by student investigator Seeta Jaikaran-Doe.
4. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years, and will then be destroyed when no longer required.
5. Any questions that I have asked have been answered to my satisfaction.
6. I agree that research data gathered from me for the study may be published provided that I cannot be identified as a participant.
7. I understand that the researchers will maintain my identity confidential and that any information I supply to the researcher will be used only for the purposes of the research.
8. I agree to my school participating in this investigation and understand that I may withdraw it at any time without any effect.

Name of School_______________________________________

Name of Principal_____________________________________

Signature_________________________ Date:______________

Statement by Investigator

I have explained the project & the implications of participation to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

The participant has received the Information Sheet where my details have been provided so participants have the opportunity to contact me prior to consenting to participate in this project.

Name of Investigator: Seeta Jaikaran-Doe Signature of Investigator____________

Appendix D: Survey instruments

University of Tasmania
Department of Education
Tasmania, 7005
Australia.

Date: ___________________________

Dear Teacher,

Thank you very much for giving your consent to participate in this survey which consists of three sections. Section one (1) and two (2) contain 24 items each; section 3 consists of 12 items. Please respond to each item using the seven point Likert scale ranging from 1, “Not Confident” to 7, “Extremely Confident” for your integration of ICT in your teaching and student learning. There is a short section with three open-ended questions.

You will take about 30 mins to complete all sections. Before you begin the survey, I would appreciate if you can complete the demographic form. The timeframe I would like you to complete the survey will be within two weeks of receiving it.

Below is the definition for ICT

ICT- Information Communications Technology refers to devices such as desktop and laptop computers, scanners, printers, copiers, interactive whiteboards, iPads, the worldwide web, external /internal software, document/digital camera, and Web 2.0.

Please try to respond to each item as honestly as you can.
Thanks very much for your cooperation.
Kind regards,

Seeta Jaikaran-Doe

Demographic Sheet

Please put a tick **(✓)** or write in the relevant box or boxes where necessary.

Gender	Male	☐
	Female	☐

What subject /subjects do you teach or are prepared to teach after graduation?	

What Form/s do you teach?

Form 1	Form 2	Form 3	Form 4	Form 5	Lower 6	Upper 6
☐	☐	☐	☐	☐	☐	☐

How many years of teaching experience do you have?

1-5	6-10	11-15	15-20	21-25	More than 25
☐	☐	☐	☐	☐	☐

Which box is closest to your qualifications?

Undergraduate degree with no teachers' training	Undergraduate degree with/and teachers' training	Master Degree	Master Degree and teachers' training	Other (specify)
☐	☐	☐	☐	

Please briefly describe in the box below any ICT programs you may have undertaken.

Section 1 Please put a tick (✓) in the appropriate column

How confident are you that you have the knowledge, skills and ability to use ICT to do the following...

NC = Not Confident PC= Partially Confident MC= Moderately Confident C= Confident VC=Very Confident EC=Extremely Confident		NC	PC	MC	C	VC	EC
1.	Demonstrate knowledge of a range of ICT to engage students						
2.	Use ICT and teaching strategies that are responsive to students' diverse backgrounds						
3.	Use ICT and teaching strategies that are responsive to students' learning styles						
4.	Use ICT and teaching strategies to support students from disadvantage backgrounds						
5.	Use ICT and teaching strategies to plan individualized learning activities for students						
6.	Use ICT to access, record, manage, and analyse student record data.						
7.	Use ICT to access, record, manage, and analyse student record data.						
8	Design lesson plans and assessments that incorporate ICT use by students						
9.	Select and organize digital content and resources						
10	Use ICT for reporting purposes, such as reporting to parents/carers						
11.	Demonstrate how ICT can be used to support literacy learning						
12.	Demonstrate how ICT can be used to support numeracy learning						
13	Design ICT activities that enable students to become active participants in their own learning						
14.	Select and use a variety of digital media (e.g. interactive whiteboard, computer) and formats (excel and power point) to communicate information						
15.	Engage parents and families in their child's schooling through ICT						
16.	Manage challenging student behaviour by encouraging the responsible use of ICT						
17.	Be aware of digital citizenship to promote student demonstration of rights and responsibilities in using digital resources and tools						
18.	Identify personal and professional learning goals in relation to using ICT						
19.	Reflect on relevant ICT research to inform professional practice						
20.	Use a range of ICT resources and devices for professional purposes						
21.	Use ICT to engage with colleagues to improve professional practice						
22.	Use ICT to collaborate for professional purposes, such as online professional communities						
23.	Evaluate how ICT use has helped to achieve specific subject area goals						
24.	Demonstrate an understanding of safe, legal and ethical use of digital information and technologies						

Note: Adapted from: Finger, G., Jamieson-Proctor, R., Cavanagh, R., Albion, P., Grimbeek, P., Bond, T., . . . Lloyd, M. (2013). Teaching Teachers for the Future (TTF) Project TPACK Survey: Summary of the key findings. *Australian Educational Computing* (Vol. 27, pp. 13-25).

Special Note: The Teaching Teachers for the Future (TTF) Project is funded by the Australian Government Department of Education, Employment and Workplace Relations (DEEWR) through the ICT Innovation Fund.

Section 2. Please put a tick (✓) in the column that you think is most appropriate

How confident are you that you have the knowledge skills and ability to support your students' use of ICT in the following?

NC = Not Confident PC= Partially Confident MC= Moderately Confident C= Confident VC=Very Confident EC=Extremely Confident		NC	PC	MC	C	VC	EC
1	To provide motivation for curriculum tasks						
2	To develop competencies in your subject area/s						
3	To actively construct knowledge that integrates curriculum areas						
4	To actively construct their own knowledge in collaboration with their peers and others						
5	To analyse their knowledge						
6	To synthesize their knowledge						
7	To demonstrate what they have learned						
8	To acquire the knowledge, skills, abilities and attitudes to deal with on-going technological change						
9	To integrate different digital media (internet, video, digital camera) to create appropriate projects						
10	To develop rich understanding about a topic of interest relevant to the curriculum area/s being studied						
11	To engage in activities of the learning process						
12	To develop understanding of the world						
13	To plan and/or manage assigned curriculum projects						
14	To engage in sustained involvement with curriculum activities						
15	To undertake formative and/or summative assessment						
16	To engage in independent learning through access to education at a time, place and pace of their own choosing						
17	To gain intercultural understanding						
18	To acquire awareness of the global implications of ICT-based technologies on society						
19	To communicate with others locally and globally						
20.	To understand and participate in the changing knowledge economy						
21.	To critically evaluate their own and society's values						
22.	To facilitate the integration of curriculum areas to construct multidisciplinary knowledge						
23.	To critically interpret and evaluate the worth of ICT-based content for specific subject area/s						
24.	To gather information and communicate with a known audience						

Note. Adapted from: Finger, G., Jamieson-Proctor, R., Cavanagh, R., Albion, P., Grimbeek, P., Bond, T., Lloyd, M. (2013). Teaching Teachers for the Future (TTF) Project TPACK Survey: Summary of the key findings. Australian Educational Computing (Vol. 27, pp. 13-25).

Special Note: The Teaching Teachers for the Future (TTF) Project is funded by the Australian Government Department of Education, Employment and Workplace Relations (DEEWR) through the ICT Innovation Fund.

Section 3 A

This section consists of two short sets of items. At the end you are invited to participate in an interview which will be mutually arranged at a time that is convenient for both of us.

How confident are you to use the following devices for your teaching?

NC= Not Confident PC = Partially Confident MC = Moderately Confident C = Confident VC = Very Confident EC = Extremely Confident	NC	PC	MC	C	VC	EC
Computer						
Interactive whiteboard (Smart Board)						
Multi-media devices						
Webpage design						
Digital camera/document camera						
Word processing						
Databases						
Spreadsheet						
External software packages						
Internal software packages						
World Wide Web						
Digital video for production and editing						

Other –please specify

Section 3B

In-service teachers
What were the major challenges you encountered in the process of integrating ICT in the delivery of instructional activities?

In-service teachers
Please describe the major challenges your students encountered in the process of learning with ICT.

Pre-service teachers
What are the major challenges you anticipate you may encounter in the process of integrating ICT in the delivery of instructional activities?

You are almost finished

Pre-service teachers
What are the major challenges you anticipate your students would encounter in the process of learning with ICT?

I shall be following up this activity with an interview that will further explore your ICT experiences. If you are interested in participating, then please tick the box below and write in your name, telephone number and an email address in the space provided. The interview will take about 30 mins.

I am interested in participating in the interview ☐

Name:

Telephone number:

Email address

Please note that your information will remain very confidential and you will be free to withdraw from the interview session at any time.
Thanks very much for participating in the survey. You have demonstrated a lot of patience.
If you have any problems please email me at seetam@utas.edu.au or phone 761-6211/655-5828.

Appendix E: Sample questions for semi-structured interviews

Sample questions for in-service teachers

1. What subject do you teach?
2. What comes to your mind when you hear the word "ICT" (Information Communication Technologies)?
3. How confident are you to use ICT for your teaching and student learning? Why do you think so?
4. What do you understand by the acronym TPACK (Technological Pedagogical Content Knowledge?
5. What support is provided to you and your students to facilitate the use of the affordances of the eConnect and Learn program?
6. What strategies impress you most about ICT integration when you attend ICT seminars, workshops and conferences?
7. Describe strategies to demonstrate how you integrate computers and related devices for teaching and student learning.
8. From your observation, how do your peers integrate computers and related devices for teaching and student learning?
9. Describe some changes you have noticed in students' attitude when you integrate ICT resources in your teaching.
10. What are your concerns for ICT integration in your school?
11. What implications do you think are there for the future of the eConnect and Learn program?
12. Are there any questions you would like to ask?

Sample questions for pre-service teachers

1. What is your major subject area?
2. What comes to your mind when you hear the word "ICT" (Information Communication Technologies)?

3. How confident are you to use ICT for your teaching and student learning? Why do you this so?
4. What do you understand by the acronym TPACK (Technological Pedagogical Content Knowledge?
5. What courses have you done at the University of Trinidad and Tobago to enhance the integration of ICT for your teaching and student learning?
6. Describe some strategies related to ICT integration you have observed your mentor teacher implement during teaching practicum?
7. What is your perception of the eConnect and Learn which began since 2010 in secondary schools?
8. Describe two methods to demonstrate how you can integrate ICT for teaching and learning.
9. Describe how you use the affordances of eConnect and Learn program during your teaching practicum.
10. What resources are important to you for the integration of ICT for your future profession?
11. Identify some ways you are prepared to use the eConnect and Learn program in the future?
12. Based on your observation on the use of computers and related devices, what do you think are the implications for the future of the eConnect and Learn program?
13. Do you have any questions?

Sample questions for school supervisors

1. What were your expectations for the implementation of the eConnect and Learn program for your teachers and students?
2. What challenges and benefits were encountered by the schools from an analysis of the monthly reports you receive on the eConnect and Learn program?
3. What teacher education programs have been provided by the Ministry of Education for effective integration of the eConnect and Learn program?
4. To what extent do you think the learning environment was organized to facilitate the implementation of the eConnect and Learn program?

5. Describe the metrics you normally use to measure the success of the eConnect and Learn program?
6. How are parents involved in the eConnect and Learn program?
7. Can you describe some of the ICT resources that have been provided for teachers and students to enhance the effective use of laptop computers?
8. Can you share some recommendations you have made about the eConnect and Learn program with your principals? What recommendations would you like to make for the future of the program?
9. Do you have any questions?

Sample questions for the ICT Technicians

1. What is your portfolio in the school?
2. Who is the provider for the internet and WiFi service in your school? What process is put in place to repair computers when they are damaged?
3. Do you provide a replacement for student computers when they are under repair? How long does it take to repair damaged computers?
4. Under whose supervision do you work?
5. What qualifications do you need to become an ICT technician?
6. What hot-line service is available to teachers and students when they need advice relating to the laptop computers?
7. How many ICT technicians work in this schools?
8. What are your concerns for the eConnect and Learn program?
9. What recommendations would you like to make?
10. Do you have any questions?

Sample questions for Director of the eConnect and Learn program

1 What is your portfolio?

2 Describe the metrics you normally use to measure the success of the eConnect and Learn program?

3. From your research on the program, how will you evaluate the current use of the laptop computers in schools?
4. Describe the features of the laptops provided to students?
5. What policies were developed to ensure the successful implementation of the program?
6. What are some of the feedbacks you have received from stakeholders about the program?
7. Who is responsible for the provision and distribution of the laptops?
8. This is a huge program in the country. To date how much money have you spent on the program?
9. What additional resources were provided to enhance teachers and students' use of the program?
10. What are your concerns for the program and what recommendations would you like to make?
11. Do you have any questions?

Appendix F: Section of a sample of in-service teacher's transcript

Sample Transcript

Salutations and Greetings

7

8

9

10 Q: What subject do you teach?

11 A: Visual arts

12 Q: Not Art and Craft?

13 A: It's no longer Art and Craft. In secondary schools is Visual Arts. It's part of the Visual Arts section component, Visual and Performing Arts. I do the Visual Arts part. The component will have music, dance, theatre, so I will do the drawing, painting, 3D things like that.

14 Q: Have you ever heard the term TPACK?

15 A: Yes, but I don't really know what it is about. I've heard it already.

16 Q: (TPACK explanation) When you hear the term ICT what comes to mind?

17 A: Basically integrating technology with teaching, things like that.

18 Q: Do you know some of the components of ICT?

19 A: The basic stuff, like you incorporate technology while teaching and letting students be more literate in terms of using the computer.

20 Q: How confident are you, using the scale below that you have the knowledge, skills and ability to integrate ICT into your teaching?

21 A: I think I am very confident.

22 Q: Why you say you are very confident?

23 A: Because I have the skills in terms of doing it and because of the infrastructure here it is such a challenge, but in terms of me having the skill I know that I am confident of doing it. But in terms of having it, being able to really teach it to a child it is difficult because we don’t have internet access, and the time it will take, but if we had that though we would be able to do everything properly. But How I going to do it? I don’t have WiFi connected in the Arts room and the children’s computer basically we have no connection and how we going to do it?

24 Q: OK I understand your predicament. What is your perception of the technology program, eConnect and Learn that started in 2010?

25 A: I personally think that it’s a waste of money. That is my personal opinion because I am seeing children not being able to use this properly, they don’t appreciate it. I think it is a waste of money and personally I don’t like that. Because it doesn’t do anything it’s just the fact that they just get the laptop, everybody is excited to get the laptop. The students were playing with them in the classroom. They don’t appreciate it because all they want a laptop for is to go on You Tube and listen to Jewels and things like that. I don’t know that if we had the internet in school if things might have been different but the reality of the situation is yes, these students have the laptop, they are not grateful for it most of them and we cannot use it.

26 Q: So how do they get games or You Tube if they do not have internet connection?

27 A: No, that’s the thing. They don’t have it because there is a block on Facebook and YouTube. Now I think that YouTube is a useful tool for them up to a point as well because in terms of art development they can learn a lot. Now that’s the whole thing, they think that the laptop is a waste of time because they can’t get YouTube on it. And when we were younger I am so grateful for getting a laptop to get the job done.

28 They don’t feel like that because I think this new generation of children they get things too easy. They get free books, free laptops, free food in school, and free transportation. I feel that if someone tried to intervene in fixing this, I think that they should have part payment by parents, like have some kind of company selling these laptops and the government cover half the cost and the parents pay for the other half, and then the children might be able to appreciate it.

29 Q: Do you think there should be a pilot project. They just gave out the computers and they didn’t put the infrastructure in place. I think that their thinking is that every student will have a laptop in the classroom and the teachers will be able to use the laptop with each student, but seeing that they didn’t put the infrastructure in place there is a big problem.

30 A: Well I was looking at the news and seeing it first, but I can’t remember who it was but there was a foreigner and he was talking about giving the children a Ferrari and not putting the roads in place. So you do it the first year and you do it the second year and you continue to do it the third year so when would you put things in place? Then you are looking at the security of the children bringing the laptop back and forth, then when they bring the laptop to school, who is going to secure the laptop. Now plenty people seriously realise that we are teachers, yes, but the time is only so limited, when you take 10 minutes off a 35 minute period, too much time wasted in securing this thing, and we can’t get to the actual teaching. It is difficult and I think that we have to work this laptop thing on the projector and nobody like the idea.

31 Q: So it is very difficult for you to use the laptop in school and therefore are you not using it with your students?

32 A: What I do I would bring work from home and use it on a flash drive which defeats the whole purpose. I don’t think that was the way it was supposed to work. The only way to get it done because the only place that has internet access is in the library. I cannot carry a whole art class to the library; I can’t carry paints there. I can’t do anything, so that’s not helping me at all. So I am going back to the old way, because yes, I can bring information on a flash drive but I cannot connect internet to the arts room, so there is only so much I can do.

33 Q: I understand the situation.

34 A: Everybody has that same problem because we do want to teach using it. It is very interactive. It’s nice and everything, but it’s just like, we are missing a lot.

35 Q: Yes. I can see teachers are willing to use it if the infrastructure is there..

36 A: Exactly

Appendix G: Descriptive statistics for normality: TK, TPK/TCK and TPACK

Case Processing Summary

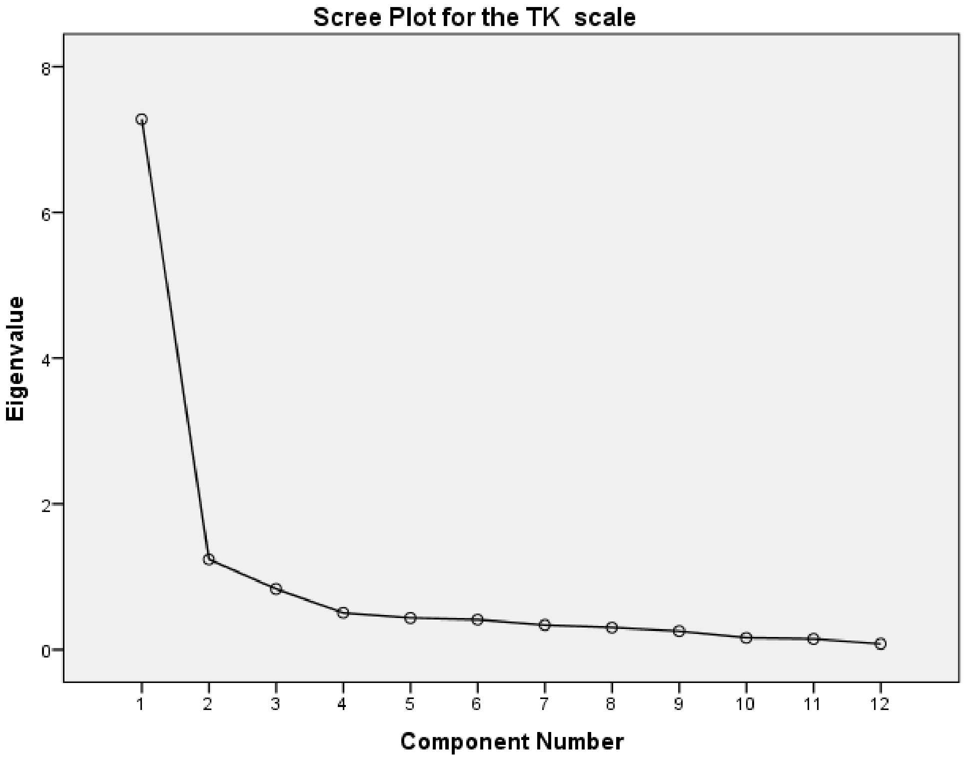
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
TPK/TCK	226	100.0%	0	0.0%	226	100.0%
TPACK	222	98.2%	4	1.8%	226	100.0%
TK	220	97.3%	6	2.7%	226	100.0%

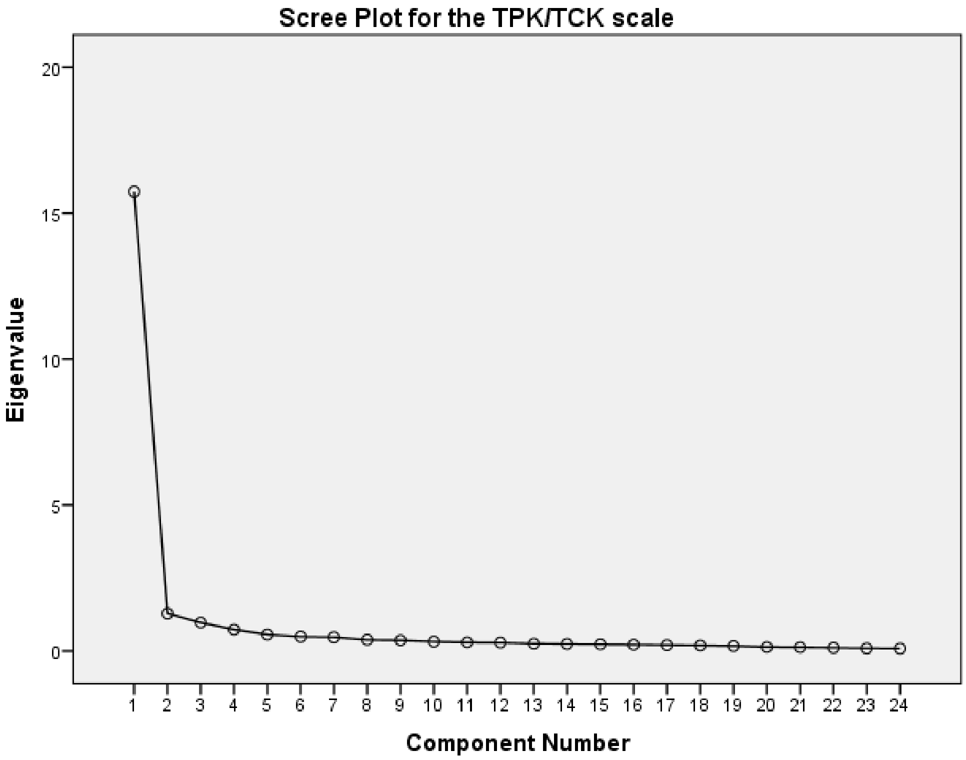
Descriptive statistics for normality: TK, TPK/TCK and TPACK.

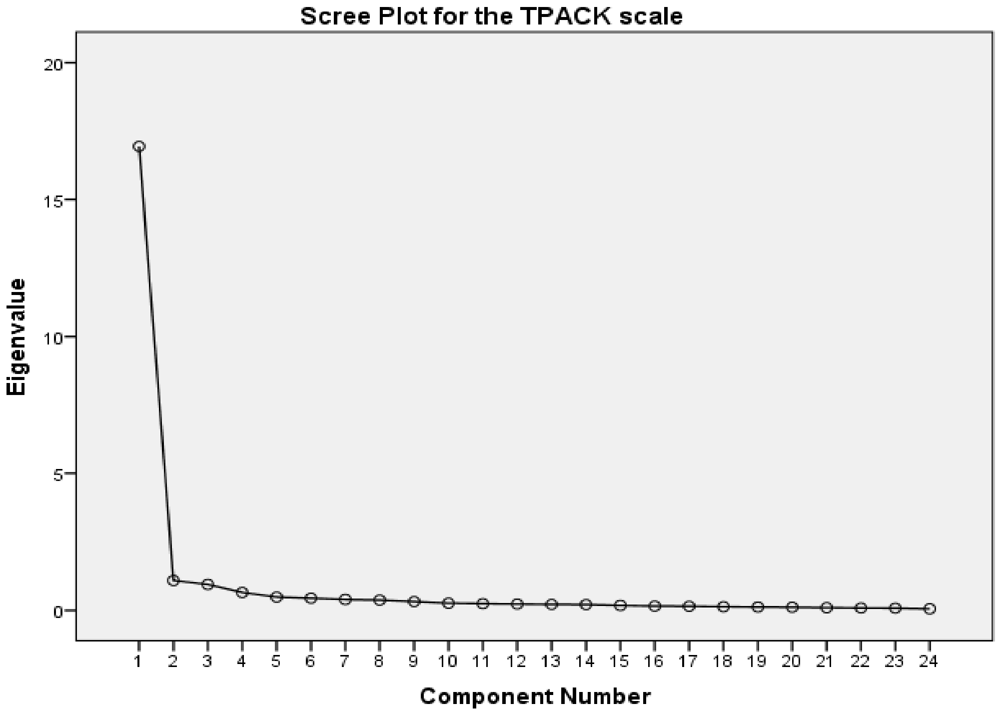
Descriptives			Statistic	Std. Error
TPKTCK	Mean		3.55	.067
	95% Confidence Interval for Mean	Lower Bound	3.42	
		Upper Bound	3.68	
	5% Trimmed Mean		3.56	
	Median		3.65	
	Variance		1.000	
	Std. Deviation		1.000	
	Minimum		1	
	Maximum		6	
	Range		5	
	Interquartile Range		1	
	Skewness		-.136	.162
	Kurtosis		-.456	.322
TPACK	Mean		3.63	.067
	95% Confidence Interval for Mean	Lower Bound	3.50	
		Upper Bound	3.76	
	5% Trimmed Mean		3.64	
	Median		3.63	
	Variance		.994	
	Std. Deviation		.997	
	Minimum		1	
	Maximum		6	
	Range		5	

Descriptives			Statistic	Std. Error
	Interquartile Range		1	
	Skewness		-.068	.163
	Kurtosis		-.401	.325
	Mean		3.63	.074
	95% Confidence Interval for Mean	Lower Bound	3.49	
		Upper Bound	3.78	
	5% Trimmed Mean		3.62	
	Median		3.60	
	Variance		1.212	
TK	Std. Deviation		1.101	
	Minimum		1	
	Maximum		6	
	Range		5	
	Interquartile Range		1	
	Skewness		.152	.164
	Kurtosis		-.412	.327

Appendix H: Scree plots for TK, TPK/TCK and TPACK







Appendix I: Case processing summary and reliability statistics

RELIABILITY for TK

/VARIABLES=Q3.1 Q3.2 Q3.3 Q3.4 Q3.5 Q3.6 Q3.7 Q3.8 Q3.9 Q3.10 Q3.11 Q3.12

/SCALE('TK') ALL

/MODEL=ALPHA.

Case Processing Summary

		N	%
	Valid	213	94.2
Cases	Excluded[a]	13	5.8
	Total	226	100.0

[a]Listwise deletion based on all variables in the procedure.

Reliability Statistics for TK

Cronbach's Alpha	N.of Items
.943	12

RELIABILITY for TPK/TCK

/VARIABLES=Q1.1 Q1.2 Q1.3 Q1.4 Q1.5 Q1.6 Q1.7 Q1.8 Q1.9 Q1.10 Q1.11 Q1.12 Q1.13 Q1.14 Q1.15 Q1.16 Q1.17 Q1.18 Q1.19 Q1.20 Q1.21 Q1.22 Q1.23 Q1.24

/SCALE('TPK/TCK') ALL

/MODEL=ALPHA.

Scale: TPK/TCK

Case Processing Summary

		N	%
	Valid	196	86.7
Cases	Excludeda	30	13.3
	Total	226	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics for TPK/TCK

Cronbach's Alpha	N of Items
.978	24

RELIABILITY for TPACK

/VARIABLES=Q2.1 Q2.2 Q2.3 Q2.4 Q2.5 Q2.6 Q2.7 Q2.8 Q2.9 Q2.10 Q2.11 Q2.12 Q2.13 Q2.14 Q2.15 Q2.16 Q2.17 Q2.18 Q2.19 Q2.20 Q2.21 Q2.22 Q2.23 Q2.24

/SCALE('TPACK') ALL

/MODEL=ALPHA.

Scale: TPACK

Case Processing Summary

		N	%
	Valid	206	91.2
Cases	Excluded[a]	20	8.8
	Total	226	100.0

[a]List-wise deletion based on all variables in the procedure.

Reliability Statistics for TPACK

Cronbach's Alpha	No. of Items
.982	24

Appendix J: Univariate Analysis of Variance for TK

```
UNIANOVA TK BY Experiencecategory schoolgroup
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /POSTHOC=Experiencecategory(SCHEFFE)
  /PLOT=PROFILE(Experiencecategory*schoolgroup)
  /PRINT=ETASQ HOMOGENEITY DESCRIPTIVE
  /CRITERIA=ALPHA(.05)
  /DESIGN=Experiencecategory schoolgroup
Experiencecategory*schoolgroup.
```

Univariate Analysis of Variance

[DataSet1] C:\Users\seetam\Desktop\Thesis SPSS.sav

Notes

Output Created		01-SEP-2015 22:06:29
Comments		
Input	Data	C:\Users\seetam\Desktop\Thesis SPSS.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	226
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the model.
Syntax		UNIANOVA TK BY Experiencecategory schoolgroup /METHOD=SSTYPE(3) /INTERCEPT=INCLUDE /POSTHOC=Experiencecategory(SCHEFFE) /PLOT=PROFILE(Experiencecategory*schoolgroup) /PRINT=ETASQ HOMOGENEITY DESCRIPTIVE /CRITERIA=ALPHA(.05) /DESIGN=Experiencecategory schoolgroup Experiencecategory*schoolgroup.
Resources	Processor Time	00:00:00.17
	Elapsed Time	00:00:00.15

[DataSet1] C:\Users\seetam\Desktop\Thesis SPSS.sav

Between-Subjects Factors

		Value Label	N
Teaching experience in four levels	1	1-5 years	39
	2	6-10 years	38
	3	11-15 years	48
	4	>15 years	41
Government and Denominational secondary schools	1	Government secondary schools	86
	2	Denominational secondary schools	80

Descriptive Statistics

Dependent Variable: TK

Teaching Experience in four levels	Government and Denominational secondary schools	Mean	Std. Deviation	N
1 1-5 years	1 Government secondary schools	4.01	1.065	15
	2 Denominational secondary schools	3.34	.728	24
	Total	3.60	.920	39
2 6-10 years	1 Government secondary schools	3.81	1.168	17
	2 Denominational secondary schools	3.85	.872	21
	Total	3.83	1.001	38
3 11-15 years	1 Government secondary schools	3.10	1.001	26
	2 Denominational secondary schools	3.35	.955	22
	Total	3.22	.978	48
4 >15 years	1 Government secondary schools	3.10	1.015	28
	2 Denominational secondary schools	2.69	.865	13
	Total	2.97	.978	41
Total	1 Government secondary schools	3.40	1.105	86
	2 Denominational secondary schools	3.37	.917	80
	Total	3.39	1.016	166

Levene's Test of Equality of Error Variances[a]

Dependent Variable: TK

F	df1	df2	Sig.
.863	7	158	.538

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Experiencecategory + schoolgroup + Experiencecategory * schoolgroup

Tests of Between-Subjects Effects

Dependent Variable: TK

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	24.288[a]	7	3.470	3.754	.001	.143
Intercept	1805.098	1	1805.098	1953.003	.000	.925
Experiencecategory	20.360	3	6.787	7.343	.000	.122
schoolgroup	1.473	1	1.473	1.594	.209	.010
Experiencecategory * schoolgroup	5.318	3	1.773	1.918	.129	.035
Error	146.034	158	.924			
Total	2072.921	166				
Corrected Total	170.322	165				

a. R Squared = .143 (Adjusted R Squared = .105)

Post Hoc Tests

Experience in four levels

Multiple Comparisons

Dependent Variable: TK

Scheffe

(I) Experience in four levels	(J) Experience in four levels	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 1-5 years	2 6-10 years	-.24	.219	.762	-.86	.38
	3 11-15 years	.38	.207	.339	-.20	.97
	4 >15 years	.63*	.215	.038	.02	1.24
2 6-10 years	1 1-5 years	.24	.219	.762	-.38	.86
	3 11-15 years	.62*	.209	.036	.03	1.21
	4 >15 years	.87*	.216	.002	.25	1.48
3 11-15 years	1 1-5 years	-.38	.207	.339	-.97	.20
	2 6-10 years	-.62*	.209	.036	-1.21	-.03
	4 >15 years	.25	.204	.687	-.33	.83
4 >15 years	1 1-5 years	-.63*	.215	.038	-1.24	-.02
	2 6-10 years	-.87*	.216	.002	-1.48	-.25
	3 11-15 years	-.25	.204	.687	-.83	.33

Based on observed means.

The error term is Mean Square(Error) = .924.

*. The mean difference is significant at the .05 level.

Homogeneous Subsets

TK

Scheffe[a,b,c]

Experience in four levels	N	Subset		
		1	2	3
4 >15 years	41	2.97		
3 11-15 years	48	3.22	3.22	
1 1-5 years	39		3.60	3.60
2 6-10 years	38			3.83
Sig.		.710	.359	.743

Means for groups in homogeneous subsets are displayed.

Based on observed means.

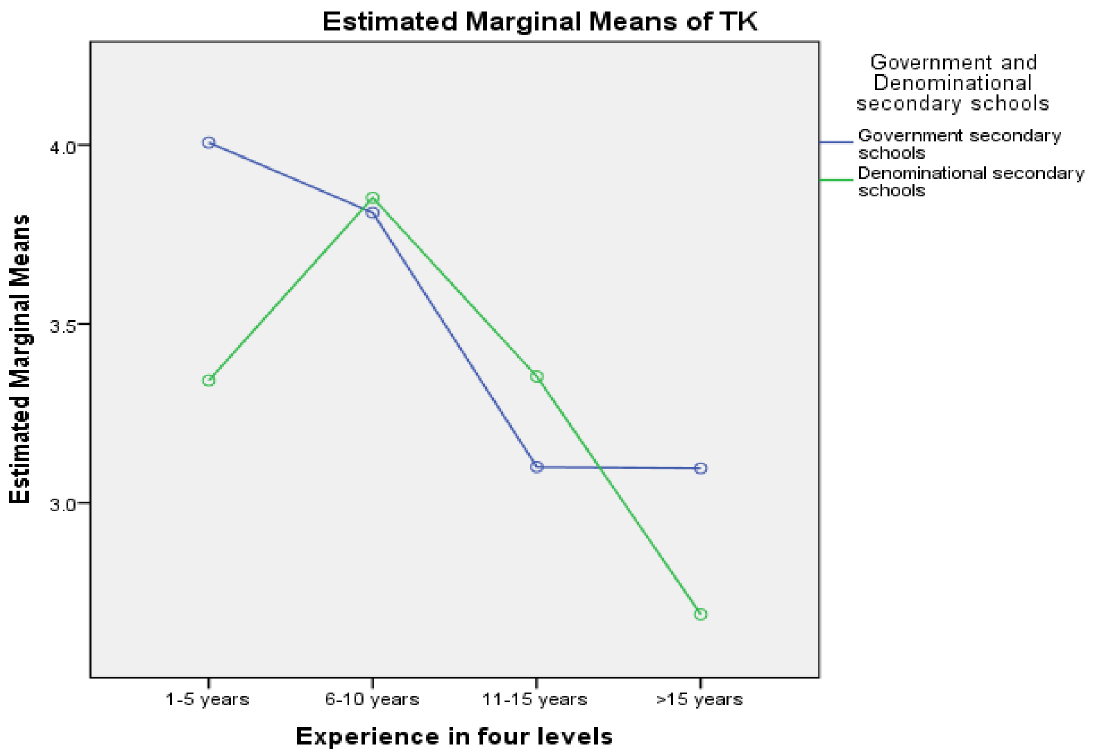
The error term is Mean Square(Error) = .924.

a. Uses Harmonic Mean Sample Size = 41.161.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

c. Alpha = .05.

Profile Plots



Appendix K: Themes and constructed categories

The following table contains a range of responses in relation to Research Questions 7 and 8. These were open ended questions and therefore participants were encouraged to give as much detail as possible. As a result, the responses given by participants varied, with multiple answers given for a single question. The responses were displayed under the four themes, teacher support, challenges of the eCAL program, pedagogy with computers and related devices, and implications for the future of the eConnect and Learn program, and were organised under each constructed category. The number of responses is computed separately in percentage for each group of participants. Although participants discussed the criteria under the categories, they did not necessarily use them for pedagogical practices. Categories and themes were extracted from NVIVO.

Research Question 7

Can Moersch's (2010) Levels of Teaching Innovation be used to review and interpret teachers' interview data relating to pedagogical practices with computers and related devices?

Themes	Categories	Pre-service teachers n = 15	In-service teachers *n* =21	ICT Technicians *n* = 5	School supervisors *n* = 3	Director *n* = 1
Teacher Support	**Infrastructure**					
	Internet connection	66%	100%	100%	100%	100%
	Electrical installation	20%	100%	60%	-	-
	Security	7%	76%	80%	33%	100%
	Technical assistance	-	86%	100%	100%	100%
	Computer lab	67%	38%	60%	33%	100%
	Resources					
	Computers and related devices	47%	100%	100%	100%	100%
	Access to use resources in school	33%	90%	60%	-	-

Themes	Categories	Pre-service teachers n = 15	In-service teachers *n* =21	ICT Technicians *n* = 5	School supervisors *n* = 3	Director *n* = 1
	Access to take resources at home	-	42%	40%	33%	-
	Personal resources	-	38%	40%	-	100%
	Professional development					
	Workshops	27%	100%	60%	100%	100%
	Time allocation	-	57%	80%	66%	100%
	Frequency	-	57%	40%	66%	-
	Online learning	33%	24%	40%	33%	100%
	Collaboration					
	Formal	-	48%	40%	33%	-
	Informal	-	57%	-	66%	-
	Time Allocation	-	71%	-	33%	-
	Supervision	-	71%	40%	66%	-
Pedagogy with Computers	**ICT Perception**					
	ICT Devices	47%	34%	-	-	-
	Use of ICT	41%	48%	-	-	-
	Application	6%	9%	-	-	-
	Synthesis	6%	9%	-	-	-
	Knowledge of TPACK					
	No knowledge	60%	90%	-	-	-
	Technology and pedagogy	26%	10%	-	-	-
	ICT integration	7%	-	-	-	-
	Technology and Science	7%	-	-	-	-
	Confidence to use ICT					
	Partially confident	20%	24%	-	-	-
	Moderately confident	40%	29%	-	-	-
	Confident	40%	33%	-	-	-
	Very confident	-	14%	-	-	-

Themes	Categories	Pre-service teachers n = 15	In-service teachers *n* =21	ICT Technicians *n* = 5	School supervisors *n* = 3	Director *n* = 1
	Pedagogical practices					
	21st Century teaching and learning	33%	14%	40%	100%	-
	Differentiation	26%	9%	-	-	-
	Task analysis	40%	14%	-	-	-
	Modelling	33%	19%	-	-	-
	Project based	20%	24%	-	-	-
	Downloaded materials for pedagogy	53%	48%	-	-	-
	Creating games, puzzles, videos, lesson plans	40%	9%	-	-	-
	Designing	26%	9%	-	-	-
	Awareness of peers' pedagogical practices with ICT	-	14 66%	-	-	
	Tools for ICT integration					
	Power- point	100%	66%	-	66%	-
	Videos and DVD	100%	42%	-	100%	-
	Document cameras	10 66%	14%	-	-	-
	email	33%	33%	100%	33%	-
	websites	53%	19%	60%	66%	-
	Social media	33%	14%	20%	66%	-
	Spread sheet	60%	29%	-	100%	-
	Word Processing	86%	33%	-	66%	-
	Hyperlinks	33%	24%	-	66%	-
	Simulation software	26%	3%	-	33%	
	WordPress	6%	9%	-	-	
	External software	-	29%	-	33%	100%
	Webinars	-	14%	-	-	-
	Blogs	53%	6%	-	-	-

Themes	Categories	Pre-service teachers n = 15	In-service teachers *n* =21	ICT Technicians *n* = 5	School supervisors *n* = 3	Director *n* = 1
	ICT integration					
	Set Induction	40%	24%	-	66%	-
	Student presentation	-	48%	-	100%	
	Student engagement	66%)	17%	-	100%	
	Assessment	-	9%	20%	33%	
	Integration of curriculum areas	73%	25%	-	66%	

Research Question 8: What implications are there for the future of the eConnect and Learn program in Trinidad and Tobago?

Themes	Categories	Pre-service teachers n = 15	In-service teachers *n* =21	ICT Technicians *n* = 5	School supervisors *n* = 3	Director *n* = 1
Indications for the future of the eConnect and Learn program	**Professional Education**					
	Inappropriate use by students	66%	71%	100%	100%	100%
	Student educated to use computers	80%	17%	40%	100%	100%
	ICT integration for teachers	66%	25%	40%	100%	100%
	Resources					
	School's policy	6%	38%	60%	100%	-
	Photocopying	-	76%	40%	66%	-
	Alternative to computers	47%	24%	80%	-	100%
	Take home school resources	-	48%		-	-
	Best practices					
	OER	20%	24%	-	66%	100%
	Research promotion	66%	38%	40%	66%	100%
	Conferences	-	81%	-	33%	-
	Transformation of culture	33%	17%	-	66%	-
	Expectations					
	Ethical use	33%	24%	40%	66%	100%
	Implementation process	-	52%	40%	33%	-
	Distribution of laptops	20%	100%	100%	100%	100%
	Security	40%	86%	100%	100%	100%
	Evaluation of the program	-	71%	60%	66%	100%
	Advantages	47%	66%		100%	
	Recommendations					
	Trust	6%	38%	-	-	-
	Professional development	33%	33	60%	33%	100%
	Subsidy for acquisition of laptop computers for teachers	-	48%	-	-	-
	Change the dependency culture	20%	17%	100%	33%	100%
	Research promotion	40%	48%	20%	100%	100%
	Curriculum redesign	33%	9%	-	100%	100%
	Make resources available	20%	17%	100%	100%	100%

Themes	Categories	Pre-service teachers *n* = 15	In-service teachers *n* =21	ICT Technicians *n* = 5	School supervisors *n* = 3	Director *n* = 1
	Appropriate infrastructure	100%	100%	100%	100%	100%
	Alternative to laptops	33%	24%	-	-	100%
	Student training	80%	6%	40%	100%	100%
	Collaboration among departments	- -	3%	-	66%	-
	Warranty	-	48%	100%	100%	100%
Challenges of the eConnect and Learn program						
	Provision of resources	33%	100%	100%	66%	-
	Constraints of purchasing resources	-	48%	100%	66%	
	Coping strategies	20%	52%	-	-	-
	Frequency of utilizing resources	-	81%	-	33%	-
	Collaboration					
	Method	73%	48%	-	66%	-
	Frequency	-	48%	-	-	-
	Time constraint	47%	71%			
	Supervision	-	62%	40%	-	-
	Teacher beliefs					
	Academic achievement	47%	81%	-	100%	100%
	Unfairness	20%	38%	80%	-	-
	Technical assistance	20%	90%	100%	66%	100%
	Administrators	33%	81%	60%	33%	-
	Ministry of Education	7%	76%	100%	66%	100%

Appendix L: Word Cloud

This Word Cloud was generated from the nodes in NVIVO software. It displays the most frequent words used in the semi-structured interview. The size of the word indicates the frequency of occurrence.